DRAFT

Shoreline Analysis Report for the Town of Beaux Arts Village: Lake Washington Shoreline

July 2010
TWC Reference # 090522

Prepared for:

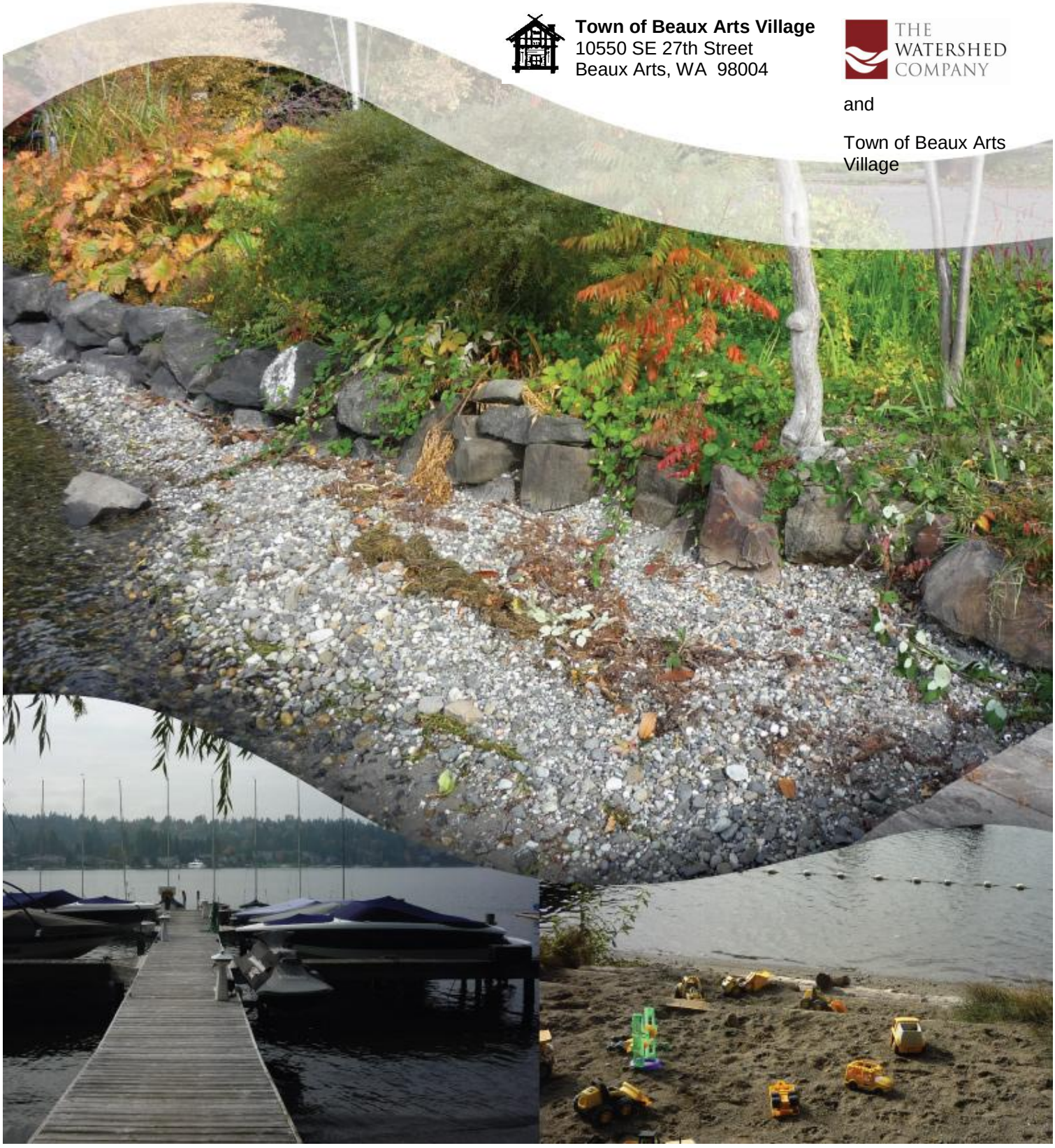
Town of Beaux Arts Village
10550 SE 27th Street
Beaux Arts, WA 98004

Prepared by:

THE WATERSHED COMPANY

and

Town of Beaux Arts Village



DRAFT

TOWN OF BEAUX ARTS VILLAGE
GRANT NO. 1000065

SHORELINE ANALYSIS REPORT
Town of Beaux Arts Village: Lake Washington Shoreline

Prepared for:

Town of Beaux Arts Village
10550 SE 27th Street
Beaux Arts, WA 98004

Prepared by:

THE WATERSHED COMPANY
750 Sixth Street South
Kirkland . WA 98033
p 425.822.5242
f 425.827.8136
watershedco.com

Town of Beaux Arts Village

July 2, 2010

The Watershed Company Reference Number:
090522

This report was funded in part through a grant from the Washington Department of Ecology.

The Watershed Company Contact Person:
Amy Summe

Town of Beaux Arts Village Contact Person:
Mona Green

Cite this document as:
The Watershed Company and Town of Beaux Arts Village. July 2010. DRAFT Shoreline Analysis Report for the Town of Beaux Arts Village: Lake Washington Shoreline. Prepared for the Town of Beaux Arts Village.

TABLE OF CONTENTS

Page #

LIST OF EXHIBITS

LIST OF TABLES

SHORELINE ANALYSIS REPORT

TOWN OF BEAUX ARTS VILLAGE'S LAKE WASHINGTON SHORELINE

1 INTRODUCTION

1.1 Background and Purpose

The Town of Beaux Arts Village (Town) obtained a grant from the Washington Department of Ecology (Ecology) in 2009 to complete a comprehensive Shoreline Master Program (SMP) update. One of the first steps of the update process is to inventory and characterize the Town's shorelines as defined by the state's Shoreline Management Act (SMA) (RCW 90.58). This inventory was conducted in accordance with the Shoreline Master Program Guidelines (Guidelines, Chapter 173-26 WAC) and project Scope of Work promulgated by Ecology, and includes all areas within current Town limits. Under these Guidelines, the Town must identify and assemble the most current, accurate and complete scientific and technical information available that is applicable. This shoreline inventory and analysis will describe existing conditions and characterize ecological functions in the shoreline jurisdiction. This will serve as the baseline against which the impacts of future development actions in the shoreline will be measured. The Guidelines require that the Town demonstrate that its updated SMP yields "no net loss" in shoreline ecological functions relative to the baseline due to its implementation.

A list of potential information sources was compiled and an information request letter was distributed to potential interested parties and agencies that may have relevant information. Collected information was supplemented with other resources such as Town documents, scientific literature, personal communications, aerial photographs, Internet data, and a brief physical inventory of the Town's shorelines.

1.2 Shoreline Jurisdiction

As defined by the Shoreline Management Act of 1971, shorelines include certain waters of the State plus their associated "shorelands." At a minimum, the waterbodies designated as shorelines of the State are streams whose mean annual flow is 20 cubic feet per second (cfs) or greater, lakes whose area is greater than 20 acres, and all marine waters. Shorelands are defined as:

> "those lands extending landward for 200 feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward 200 feet from such floodways; and all wetlands and river deltas associated with the streams, lakes, and tidal waters which are subject to the provisions of this chapter…Any county or city may determine that portion of a one-hundred-year-floodplain to be included in its master program as long as such portion includes, as a minimum, the floodway and the adjacent land extending landward two hundred feet therefrom… Any city or county may also include in its master program land necessary for buffers for critical areas (RCW 90.58.030)"

The ordinary high water mark is:

> "that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation as that condition exists on June 1, 1971, as it may naturally change thereafter, or as it may change thereafter in accordance with permits issued by a local government or the department: PROVIDED, That in any area where the ordinary high water mark cannot be found, the ordinary high water mark adjoining salt water shall be the line of mean higher high tide and the ordinary high water mark adjoining fresh water shall be the line of mean high water" (RCW 90.58.030(2)(b)).

The Town's Shoreline Management Master Program was first adopted in 1973, and then amended in 1974. The Town's existing shoreline management area includes the entirety of Lake Washington shoreline within Town limits. Because Lake Washington exceeds 1,000 acres in size, the lake is considered a Shoreline of Statewide Significance.

Washington Department of Ecology's Digital Atlas was consulted to assess whether any streams within Town limits exceed the 20 cfs cut-off. However, per the data, no streams within the Town have a mean annual flow of 20 cfs or greater. No other waterbodies within the Town boundary exceed 20 acres.

Existing Town of Beaux Arts Village wetland information and National Wetland Inventory (NWI) data were reviewed to identify potential-shoreline associated wetlands. No wetlands have been mapped in or adjacent to shoreline jurisdiction.

1.3 Study Area

Beaux Arts Village was founded in 1908 when three members of the Society of Beaux Arts purchased a 50-acre tract of forest land on the Lake Washington shoreline and set aside use of the shoreline for all current and future owners within the property. The first residence was constructed in 1909 and by 1916 fifteen property owners were living in the village. After the entire village was taken over by King County during the Great Depression for back taxes, it was once again purchased in the early 1940's and individual lots were sold. Amid concerns of Bellevue's rapid expansion and in hopes of permanently protecting the shoreline area, the town officially incorporated in 1954.

The Town has changed very little since incorporation. Many of the original residences have been replaced by new (and larger) residences, but land use within the Town has remained unchanged since incorporation.

The Town is bordered by incorporated areas of Bellevue to the north, east, and south and by Lake Washington to the west. The Town's shoreline includes the entirety of the 1,146 foot Lake Washington shoreline within Town limits. The Town encompasses approximately 0.08 square miles. The study area for this report includes all land currently within the Town's proposed shoreline jurisdiction. The total area subject to the Town's updated SMP, not including aquatic area, is approximately 5.1 acres (0.01 square mile), and as mentioned, encompasses 1,146 feet of shoreline.

2 CURRENT REGULATORY FRAMEWORK SUMMARY

2.1 Town of Beaux Arts Village

The Shoreline Management Act of 1971 brought about many changes for local jurisdictions, including the Town of Beaux Arts Village. The legislative findings and policy intent of the SMA states:

> "There is, therefore, a clear and urgent demand for a planned, rational, and concerted effort, jointly performed by federal, state, and local governments, to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines (RCW 90.58.020)."

While protecting shoreline resources by regulating development, the SMA is also intended to provide balance by encouraging water-dependent or water-oriented

uses while also conserving or enhancing shoreline ecological functions and values. The SMP is based on State guidelines but tailored to the specific conditions and needs of individual communities.

The Town's first Shoreline Master Program was adopted in 1973 (Ordinance 89), and then amended in 1974 (Ordinance 100). Regulations applicable to wetlands not located within shoreline jurisdiction were created in 1992 (Ordinance 233).

Any applicant must comply with all applicable laws prior to commencing any use, development, or activity. Beaux Arts Village ensures consistency between the SMP and other Town codes, plans and programs by reviewing each for consistency during periodic updates of the Town's Comprehensive Plan as required by State statute.

2.2 State and Federal Regulations

State and federal regulations most pertinent to development in the Town's shorelines include the federal Endangered Species Act, the federal Clean Water Act, the State Shoreline Management Act, and the State Hydraulic Code. Other relevant federal laws include the National Environmental Policy Act, Anadromous Fish Conservation Act, Clean Air Act, and the Migratory Bird Treaty Act. State laws which address shoreline issues include the Growth Management Act, State Environmental Policy Act, tribal agreements and case law, Watershed Planning Act, Water Resources Act, Salmon Recovery Act, and the Water Quality Protection Act. A variety of agencies (e.g., U.S. Army Corps of Engineers, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Ecology, Washington Department of Fish and Wildlife) are involved in implementing these regulations, but review by these agencies of shoreline development in most cases would be triggered by in- or over-water work, discharges of fill or pollutants into the water, or substantial land clearing. Depending on the nature of the proposed development, State and federal regulations can play an important role in the design and implementation of a shoreline project, ensuring that impacts to shoreline functions and values are avoided, minimized, and/or mitigated. With the comprehensive SMP update, the Town will strive to ensure that Beaux Arts Village's SMP regulations are consistent with other State and Federal requirements and explore ways to streamline the shoreline permitting process. A summary of some of the key regulations and agency responsibilities follows.

Section 10: Section 10 of the federal Rivers and Harbors Appropriation Act of 1899 provides the U.S. Army Corps of Engineers (Corps) with authority to regulate activities that may affect navigation of "navigable" waters. Lake Washington is a designated navigable waterbody. Accordingly, proposals to construct new or modify existing in-water structures (including piers, marinas,

bulkheads, breakwaters), to excavate or fill, or to "alter or modify the course, location, condition, or capacity of" navigable waters must be reviewed and approved by the Corps.

Section 404: Section 404 of the federal Clean Water Act provides the Corps, under the oversight of the U.S. Environmental Protection Agency, with authority to regulate "discharge of dredged or fill material into waters of the United States, including wetlands" (http://www.epa.gov/owow/wetlands/pdf/reg_authority_pr.pdf). The extent of the Corps' authority and the definition of fill have been the subject of considerable legal activity. As applicable to the Town of Beaux Arts Village's shoreline jurisdiction, however, it generally means that the Corps must review and approve most activities in any wetlands and Lake Washington. Similar to SEPA requirements, the Corps is interested in avoidance, minimization, restoration, and compensation of impacts.

Federal Endangered Species Act (ESA): Section 9 of the ESA prohibits "take" of listed species. Take has been defined in Section 3 as: "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The take prohibitions of the ESA apply to everyone, so any action that results in a take of listed fish or wildlife would be a violation of the ESA and is strictly prohibited. Per Section 7 of the ESA, activities with potential to affect federally listed or proposed species and that either require federal approval, receive federal funding, or occur on federal land must be reviewed by the National Marine Fisheries Service (NOAA Fisheries) and/or U.S. Fish and Wildlife Service (USFWS) via a process called "consultation." As previously mentioned, a Corps permit under Section 10 of the Rivers and Harbors Appropriation Act is required for projects in Lake Washington.

Section 401 Water Quality Certification: Section 401 of the federal Clean Water Act allows states to review, condition, and approve or deny certain federal permitted actions that result in discharges to State waters, including wetlands. In Washington, the Department of Ecology is the State agency responsible for conducting that review, with their primary review criteria of ensuring that State water quality standards are met. Actions within streams, lakes or wetlands within the shoreline zone that require a Section 10 or Section 404 permit (see above), will also need to be reviewed by Ecology.

Hydraulic Code: Chapter 77.55 RCW (the Hydraulic Code) gives the Washington Department of Fish and Wildlife (WDFW) the authority to review, condition, and approve or deny "any construction activity that will use, divert, obstruct, or change the bed or flow of State waters." As applicable to the Town of Beaux Arts Village's shoreline jurisdiction, however, it generally means that WDFW must review and approve most activities in Lake Washington. These activities may include pier and bulkhead repair or construction, among others.

WDFW can condition projects to avoid, minimize, restore, and compensate adverse impacts.

3 ELEMENTS OF THE SHORELINE INVENTORY & SPECIFIC CONDITIONS

Development of a shoreline inventory is intended to record the existing or baseline conditions upon which the development of shoreline master program provisions will be examined to ensure the adopted regulations provide no net loss of shoreline ecological functions. At a minimum, local jurisdictions shall gather, to the extent information is relevant and readily available, the following shoreline inventory elements, as found in Table 1. The table also describes the information collected for each of the required inventory elements. Figures are provided in Appendix A and depict the various inventory pieces listed in the table, as well as additional analysis.

Table 1. Shoreline Inventory Elements and Information Sources.

Inventory Element	Information Gathered	Data Sources
Land Use Patterns	Comprehensive Plan Land Use	Comprehensive Plan
Transportation	Highways, arterials, local streets, & street ends	King County GIS
Utilities	Wastewater facilities	City of Bellevue GIS
Impervious Surfaces	Roads, parking lots, & buildings; 30m resolution, aerial photo interpretation	USGS
Vegetation	Vegetation and development types at 30m resolution, aerial photo interpretation	NOAA / USGS National Land Cover Data
Shoreline Modifications	Bulkheads, docks, boatlifts, boathouses, & moorage covers	Field Inventory (armoring), WA Department of Natural Resources (overwater cover)
Public Access Areas	Parks, public docks	Comprehensive Plan
Critical Areas	Erosion hazard areas, & fish and wildlife habitat conservation areas	WDFW GIS, King County GIS
Soils	Soils	Natural Resource Conservation Service - SSURGO

In order to break down shoreline jurisdiction into manageable units and to help evaluate differences between discrete shoreline areas, shoreline jurisdiction has been sequentially divided into two assessment areas. Assessment Area 1 includes the Western Academy of Beaux Arts (WABA) property. Assessment Area 2 includes those portions of upland single-family residential parcels located within shoreline jurisdiction as well as a property owned by the water district.

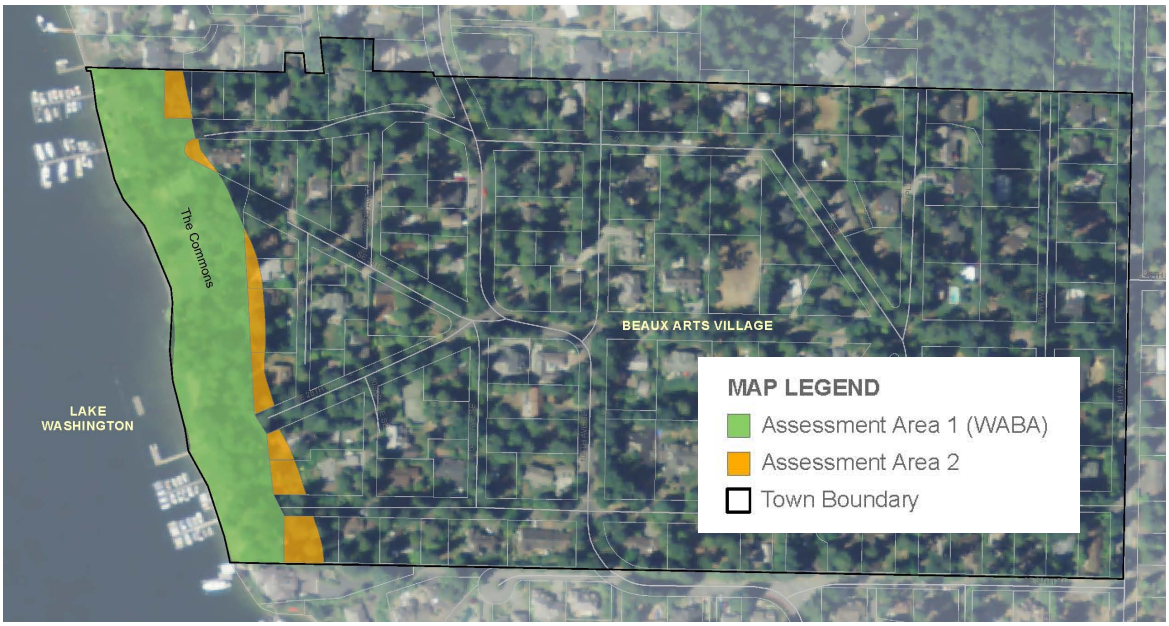


Exhibit 1. Shoreline Assessment Areas.

The following table expands upon the relevant above required inventory elements, providing specific detail and data for both assessment areas, and providing a narrative where appropriate for each element.

Table 2. Shoreline Inventory Elements by Assessment Area.

Inventory Elements	Assessment Area 1 (WABA)	Assessment Area 2 (Residential)
Land Use Patterns	**Comprehensive Plan:** Open Space Land - 100% **Current Land Use:** Open Space – 98% Utilities – 2%	**Comprehensive Plan:** Residential - 100% **Current Land Use:** Residential – 85% Utilities – 15%
Impervious Surfaces	0.23 acre - 5.3%	0.07 acre - 8.6%
Vegetated Areas	3.7 acres - 86.2%	0.66 acre - 81.5%
Shoreline Armoring	1,066 feet - 93%	NA
Overwater Cover	6 docks - 13,661 sf	NA
Public Access Areas (Park & Open Space)	4.3 acres - 100%	0.0 acres - 0%
Sensitive Areas	• The entire shoreline jurisdiction is mapped as an erosion hazard area by King County. • A bald eagle nest is mapped by WDFW at the upland edge of shoreline jurisdiction; the entire shoreline jurisdiction is part of WDFW's bald eagle buffer area.	

4 Analysis of Ecological Functions and Ecosystem Wide Processes

4.1 Lake Washington Watershed (WRIA 8)

4.1.1 Geographic Context

The Town of Beaux Arts Village is located on Lake Washington in the Puget Sound Region and contains freshwater shorelines associated with Washington State's Water Resource Inventory Area (WRIA) 8 (Exhibit 2) (http://www.ecy.wa.gov/services/gis/maps/wria/mpl/mpl8.pdf). WRIA 8 encompasses 692 square miles, collecting water from two major rivers (the Cedar and Sammamish rivers) before flowing through Lake Union and ultimately into Puget Sound via the Lake Washington Ship Canal and Hiram Chittenden locks.

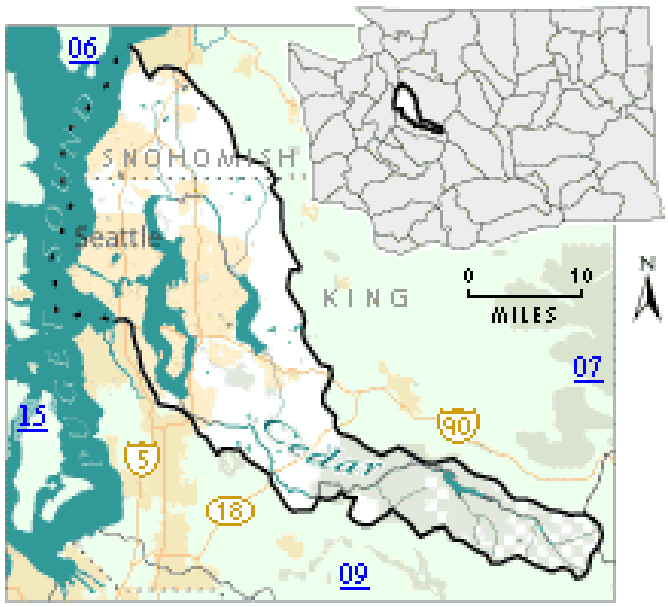


Exhibit 2. Overview of the Cedar Sammamish Water Resource Inventory Area (WRIA) 8.

4.1.2 Historic Drainage Patterns and Lake Washington Alterations

The lowering of the lake that resulted from the construction of the Lake Washington Ship Canal and Hiram Chittenden locks (completed in 1916) and the concurrent elimination of the Black River and the diversion of the Cedar River into Lake Washington were the most monumental modifications. Lake Union was connected to Lake Washington via the Montlake Cut, and the former outlet

to Lake Union was enlarged to form the Fremont Cut. Locating the locks near the western terminus of Salmon Bay converted the formerly saltwater inlet into a freshwater channel, eliminating over 7 km (4 mi.) of estuarine habitat.

Lowering Lake Washington and diverting the Cedar River affected both the fish populations and the condition of the habitat. Cedar River fish stocks were locally adapted to a riverine migration and an extensive estuary, instead of the current lengthy lacustrine migration and an abrupt transition between warm, fresh water and significantly colder, more saline conditions below the locks. Lake Washington fish stocks, while accustomed to the lengthy lacustrine migration, were also adapted to an extensive estuary. The approximately 9-foot reduction in lake level eliminated much of the available shallow-water and freshwater marsh habitat, and decreased the length of the shoreline. Chrzastowski (1983) reports a loss of 15.3 km (9.5 miles) of shoreline, and an estimated loss of 410 hectares (1,013 acres) of wetland resulting from the lowering of the lake.

The construction of the Hiram Chittenden locks and subsequent water level regulation in Lake Washington by the Corps eliminated the annual flood-driven seasonal inundation of the shoreline that historically shaped the structure of the vegetation community. The hardstem bulrush- and willow-dominated community that existed prior to 1916 has been replaced by developed shorelines with landscaped yards. The management of the lake level by the Corps to maintain a high water volume throughout the summer and subsequently lowering the lake during the late fall and winter essentially reverses the natural lake hydrograph. This reversal impacts the growth of many species of native terrestrial and emergent vegetation. Conversely, this hydrograph reversal indirectly acts to buffer shorelines from potential wind-driven wave impacts during winter storms.

The loss of natural shoreline has reduced complex shoreline features such as overhanging and emergent vegetation, woody debris (especially fallen trees with branches and/or rootwads intact), and gravel/cobble beaches. Evermann and Meek (1897) noted in 1896 that "the shore of Lake Washington is not well adapted to collecting with a seine" due to the abundant submerged woody debris, and dense underbrush, small trees, and tule (hardstem bulrush) that fringed the shoreline. The loss of native shoreline vegetation and wetlands has also reduced naturally occurring nutrients and food resources.

The woody debris, once abundant along the shoreline of Lake Washington in its historical condition has been replaced with structurally simple piers. A survey of 1991 aerial photos estimated that 4 percent of the shallow-water habitat within 30.5 meters (100 feet) of the shore was covered by residential piers (ignoring coverage by commercial structures and vessels) (Malcom, pers. comm., 22

November 1999). A study conducted in 2000 reported that there were 2,737 docks in Lake Washington, and that approximately 71 percent of the shoreline was armored (Toft 2001). The loss of complex habitat features (i.e., woody debris, overhanging vegetation, emergent vegetation), and shallow-water habitat in Lakes Washington and Sammamish has reduced the availability of prey refuge habitat and forage for juvenile salmonids.

As NOAA Fisheries- and USFWS-mandated standard conservation measures are implemented with individual shoreline projects, and bioengineering methods and other "fish-friendly" designs for shore protection are adapted to lakeshore use, the condition of the Lake Washington shoreline, in terms of fish and wildlife habitat may improve over time. However, the present availability of quality shoreline habitat for salmonids and their prey species remains substantially below its historical level. Recent and ongoing efforts to address the concern of growth management within the watershed and facilitate recovery efforts for salmon and salmon habitat, specifically for Chinook salmon, include working with local jurisdictions to implement shared strategies for salmon recovery (WRIA 8 Steering Committee 2005; WRIA 8 Steering Committee 2002).

While water quality in Lake Washington is often considered moderate to good, the present state is a tremendous improvement from its condition just 50 years ago. Prior to the formation of Metro (now part of King County's Department of Natural Resources and Parks) in 1958, local sewage treatment plants around Lake Washington discharged effluent directly into the lake, resulting in large cyanobacteria (*Oscillatoria rubescens*) blooms that made the lake unsafe for recreation. After the construction of regional wastewater treatment facilities in Renton and at West Point in Seattle, effluent discharges dropped from approximately 20 million gallons per day to zero (Edmondson 1991). The subsequent reduction in phosphorus loading from the effluent discharges resulted in relatively immediate improvements to the lake's water quality. While water clarity was measured to be only 30 inches in 1964, clarity improved to 10 feet by 1968, reaching 25 feet by 1993.

The conditions present in the surrounding watershed and tributary streams are also important influences on Lake Washington's water quality and ecological processes. Elimination of the Black River and the diversion of the Cedar River into the lake effectively doubled the amount of water moving through the Lake Washington system. Concurrent changes to the lakes water level and outflow, from the Black River to the Hiram Chittenden locks, reduced the lakes ability to naturally regulate its water quality by decreasing the quantity and quality of available wetlands and estuaries. Wetlands are critical to lake water quality, often functioning as a natural water storage and filtration system that removes excess nutrients and toxic compounds. Similarly, wetlands are an important source of food and shelter for a diverse range of terrestrial and aquatic species.

The Cedar River is now the largest source of clean freshwater input into Lake Washington, providing over 50% of the mean annual flow. Similarly, the Cedar River contributes significantly to the lakes biological diversity as the primary spawning and juvenile rearing grounds for many of the lakes diverse trout and salmon populations including coho, Chinook, sockeye, steelhead, coastal cutthroat trout, and bull trout. Minimal development in the Cedar River and its tributary streams has been a key factor in maintaining the health of salmon and trout populations and the moderate to good level of water quality currently found in Lake Washington.

4.1.3 Major Land Use Changes and Current Shoreline Condition

A key feature of urban areas is impervious surface coverage. Increases in impervious surface coverage, and the consequent reduction in soil infiltration, have been correlated with increased velocity, volume and frequency of surface water flows. This hydrologic shift alters sediment and pollutant delivery to streams and ultimately to downstream receiving water bodies (Booth 1998; Arnold and Gibbons 1996). Increased surface water flows associated with impervious surface coverage of suburban areas (20-30%) has been linked to decreased bank stability and increased erosion (May et al. 1997a). Knutson and Naef (1997), in their literature review, concluded that as little as 10 percent impervious surface coverage is sufficient to alter streambank stability and erosion. Changes in hydrology and stream morphology brought on by impervious surfaces have also been linked to shifts in macroinvertebrate community composition, which could have profound and far-reaching impacts on the productivity of a watershed (Pederson and Perkins 1986, as cited in Leavitt 1998). Changes in fish assemblages have been correlated with changes in stream temperature and base flow as a result of increased impervious surface coverage (Wang et al. 2003). Increases in flood frequency and volume have been correlated to declining salmon populations in some Puget Sound lowland streams (Moscrip and Montgomery 1997). Riparian areas can protect against these factors by moderating surface water and sediment inputs. However, while riparian quality has been shown to be inversely proportional to the level of urbanization (May et al. 1997b), impervious surface area alone is not the only component to predicting stream biological conditions (Booth et al. 2004).

Many concerns have arisen in recent years over the impacts from the urbanization of predominantly forested areas, especially areas which contain erosion-susceptible geologic substrate and relatively high gradients (Booth and Henshaw 2001). Booth et al. (2002) conclude that under typical rural land uses, impacts to watershed ecology from reduced forest-cover area can be as great or greater than similar increases in impervious area. Threshold levels of 10 percent

impervious coverage and 35 percent deforested area have been found to mark a distinct transition towards severely degraded stream conditions (Booth 2000).

In general, development is known to have detrimental effects on salmonids, particularly with spawning abundance and success. Pess et al. (2002) found that wetland occurrence, local geology, stream gradient, and land use were significantly correlated with adult coho salmon abundance. While positive correlations were found between spawner abundance and forested areas, negative correlations were found between spawner abundance and areas converted to agriculture or urban development. Fish species diversity has been found to decline with increasing levels of urban development, while cutthroat trout tend to become the dominant salmonid species (Lucchetti and Fuerstenberg 1993; Ludwa et al. 1997). The WRIA 8 Steering Committee has recently recognized the need to restore coho salmon spawning habitat in order to reduce the population of cutthroat trout, a known predator of juvenile Chinook salmon (WRIA 8 Steering Committee 2005).

The following information is presented to give historical context to the analysis of existing ecological functions and processes (i.e. baseline conditions). The urbanization of the Lake Washington watershed has increased impervious area, reduced forest cover, and increased nutrient and chemical loading to environmentally sensitive areas. These factors eventually contribute to increased storm flows, channel incision, sedimentation, and reduction in water quality, to name a few, ultimately impacting downstream receiving water bodies such as Lake Washington. The *Salmon and Steelhead Habitat Limiting Factors Report for the Cedar-Sammamish Basin (Water Resource Inventory Area 8)* (Kerwin 2001) identifies the following five "limiting habitat factors and impacts on Lake Washington:"

- The riparian shoreline of Lake Washington is highly altered from its historic state. Current and future land use practices all but eliminate the possibility of the shoreline to function as a natural shoreline to benefit salmonids;
- Introduced plant and animal species have altered trophic interactions between native animal species;
- The known historic practices and discharges into Lake Washington have contributed to the contamination of bottom sediments at specific locations;
- The presence of extensive numbers of docks, piers and bulkheads have highly altered the shoreline; and
- Riparian habitats are generally non-functional.

The remainder of this discussion describes the baseline conditions within Lake Washington in terms of the following parameters as enumerated by NOAA Fisheries' draft Lake Matrix of Pathways and Indicators established for Chinook salmon (Table 1): 1) water quality, 2) habitat access, 3) habitat elements, 4) shoreline conditions.

Table 3. Checklist for Documenting Environmental Baseline of Relevant Indicators – Draft modified by NOAA Fisheries for lakes.

PATHWAYS & INDICATORS	SUMMARY OF LAKE WASHINGTON CONDITIONS
Water Quality	
Temperature/Dissolved Oxygen	At Risk: Surface water temperatures often exceed the critical threshold for juvenile salmonids, creating inhospitable shallow nearshore areas typically between July and October. However, juvenile salmonids are not likely to be present in the nearshore at this time of year. Conversely, Dissolved Oxygen (DO) rarely falls below acceptable levels in surface waters (1-10m). However, DO concentrations below dense growths of aquatic macrophytes, Eurasian milfoil in particular, can be lethally low.
pH	At Risk: pH levels are found typically within acceptable levels, but can become higher during the late spring/early summer months.
Chem. Contamination	At Risk: Chemical contamination consists primarily of hydrocarbon input from the urbanized watershed, but the lake has also been on the 303d list for fecal coliform, ammonia, and PCBs.
Nutrients/Total P	At Risk: Nutrient levels in Lake Washington typically do not represent a problem for salmonids. However, localized algal blooms have occurred at various points throughout the lake.
Habitat Access	
Physical Barriers	At Risk: While fish passage is not physically blocked by the locks, the barrier presented by the locks and corresponding fish ladder causes stress and mortality for migrating salmonids.
Habitat Elements	
Exotic Species (in water)	Not Properly Functioning: Many invasive aquatic plants, such as Eurasian milfoil, have become extremely prevalent throughout the lake, often times outcompeting native species and reducing overall structural complexity.
Shoreline Upwelling/ Downwelling	Not Properly Functioning: The extent of shoreline armoring has reduced the natural influx of gravel via erosion processes and increased rates of sediment transport, which in turn has decreased the extent of shoreline upwelling/downwelling.
Structural Complexity (LWD/emergent/ submergent vegetation)	At Risk: Much of the loss in structural complexity dates back to the lowering of the lake by the U.S. Army Corps of Engineers during construction of the Hiram Chittenden Locks. The manual control of the lake elevation and the subsequent reversal of the natural hydrograph does not support the natural establishment of emergent vegetation similar to the historical condition. Shoreline development has decreased shoreline vegetation and subsequently removed and prevented further additions of LWD. Most shoreline wetlands have been lost with the notable exception of a few locations around the lake (e.g. Yarrow Bay, Forbes Creek).
Substrate Composition	Not Properly Functioning: Due to the extent of shoreline armoring around Lake Washington, which effectively limits the natural erosion processes leading to sediment transport, the composition of most shoreline substrates do not contain habitat suitable to most salmonids. The extensive armoring also results in a lack of habitat structure used for rearing and allocthonous inputs necessary to support foraging. Juvenile salmonids primarily feed on aquatic and terrestrial invertebrates. The lack of overhanging and emergent vegetation limits allocthonous input of both detritus and invertebrates.
Shoreline Conditions	
Shoreline Vegetation and Riparian Structure	Not Properly Functioning: Residential development around much of the lakeshore has resulted in a general lack of shoreline vegetation and

PATHWAYS & INDICATORS	SUMMARY OF LAKE WASHINGTON CONDITIONS
	riparian structure. The historical shoreline of Lake Washington included a mix of willow, dogwood, and other large shrubs along with upland conifers. The development of the lakeshore has effectively removed this native vegetation and replaced it with small shrubs and grass lawns, neither of which provides the habitat complexity of the historical shoreline.
Shoreline Gradient	Not Properly Functioning: Similar to the concerns regarding Shoreline Upwelling/Downwelling and Substrate Composition, Shoreline Gradient has also been negatively affected by shoreline armoring.

1. Water Quality: In general, Lake Washington surface water temperatures between 1 and 10 meters deep exceed 17°C from July to October. This temperature appears to be a critical threshold for the distribution of juvenile anadromous salmonids. The expectation is that shallow nearshore areas of Lake Washington would be inhospitable for bull trout and juvenile Chinook and coho salmon during periods of high temperatures.

   Conversely, dissolved oxygen (DO) levels rarely fall below 8 mg/L at similar depths. DO levels below 4 mg/L are considered dangerous for salmonids. Thus, ambient DO levels exceed acceptable levels for salmonids. However, DO concentrations below dense growths of aquatic macrophytes, Eurasian water-milfoil in particular, can be lethally low (Frodge et al. 1995).

   From 2003 through 2008, measures of pH at a 1-meter depth (King County Metro monitoring station 0814, located in Yarrow Bay) were typically between 7 and 9, exceeding 8.5 during most years in the late spring/early summer months. A pH of 9 was exceeded four times, all in May and June of 2006. Other water quality concerns include chemical contaminants and fecal coliform levels. Lake Washington was on the U.S. EPA 2004 303(d) list for fecal coliform at fifteen sample locations, ammonia at two locations, and polychlorinated biphenyls (PCBs) at one location. Chemical contamination of the waters of Lake Washington consists primarily of hydrocarbon input from the urbanized watershed. Wakeham (1977) computed a hydrocarbon budget for Lake Washington and determined that the majority of the hydrocarbons were from stormwater runoff either directly to the lake or via rivers, while 85 percent of the hydrocarbon removal is via sedimentation. Wakeham (1977) indicated that the primary source of hydrocarbons in the urban runoff to Lake Washington is automotive, both oil and grease, and products of combustion (polycyclic aromatic hydrocarbons - PAHs); outboard

engine operation likely contributes a very small fraction of total input (less than 1%). PAHs are a common pyrolytic byproduct of all internal combustion engines and are now commonly found in most aquatic systems, near industrialized and urbanized centers (Green and Trett 1989).

Overall, relatively little is known about the impacts of PAHs to aquatic organisms. Arkoosh et al. (1998) reported evidence for immunosuppression resulting from exposure to PAHs, determining that Chinook smolts from urban estuaries (Duwamish) exhibited a higher cumulative mortality after exposure to the marine pathogen *Vibrio anguillarum* than smolts from a non-urban estuary. Tissue examinations of the Chinook smolts indicated that those from the urban estuary had been exposed to higher levels of PAHs and PCBs than smolts from the non-urban estuary (Arkoosh et al. 1998).

Present nutrient levels in Lake Washington do not represent a problem for salmonids. Total phosphorus, as measured from 1995 through 2000 at Metro station 0840, varied little between seasons, and has generally been below 4 mg/L.

The *Final Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan* listed Lake Union, the Ship Canal and the Sammamish River as waterbodies with degraded water quality, but did not include Lake Washington (WRIA 8 Steering Committee 2005). The *Lake Washington Existing Conditions Report* (Tetra Tech ISG, Inc. and Parametrix, Inc. 2003) summarizes and analyzes 12 years of water quality data. The Report concludes the following:

"Overall, Lake Washington has recovered from the eutrophic, over enriched state that existed in the 1950s to 1960s. The key to rapid recovery was the lake's depth, which contained large stores of dissolved oxygen and the reduction in P loading that occurred with sewage diversion. The lake is sensitive to P loading, and the maintenance of present-day water quality is dependent on keeping P loading at or below current levels. Minimal development of the Cedar River basin has been a key factor in recovery and maintenance of lake water quality."

Note: Phosphorus (P) loading is the delivery of Phosphorus to the aquatic environment via external or internal means. External P loading is often derived from outside sources such as fertilizers and septic/sewage systems, but also occurs naturally at low background

levels. Internal P loading is derived through the release of existing nutrients lying within the lake sediments that can be released both by anoxic conditions as well as physical disturbance of sediments.

2. Habitat Access: The Hiram Chittenden Locks represent a barrier to fish passage by creating a combination of physical and biological obstacles to fish migration. While fish passage is not physically blocked by the locks, the physical and biological obstacles that the locks create, result in a significant level of stress and mortality for adult and juvenile salmonid migrants.

3. Habitat Elements: Exotic aquatic plant and animal species inhabit much of the Lake Washington system. Milfoil and fragrant white water lily are exotic aquatic macrophytes in Lake Washington that have demonstrated a negative effect on fish on occasion (Frodge et al. 1995). Reduced DO levels and consequent fish mortality has been observed within dense patches of either species in shallow, poorly circulating water (Frodge et al. 1995). Low DO conditions under aquatic macrophytes have only been observed in small lakes or in sheltered bays of Lake Washington. Yellow perch, brown bullhead, smallmouth bass, and largemouth bass are exotic predators with the potential to prey on juvenile Chinook and coho salmon. Yellow perch utilize "non-structural" areas (Paxton and Stevenson 1979) and brown bullhead are lake bottom foragers, and are thus less likely than bass to utilize developed areas. Yellow perch of predatory size are also generally deep water oriented. Largemouth bass are the most likely exotic predators in nearshore areas because of the abundant aquatic vegetation. Observing where sockeye salmon beach spawn best identifies the presence of shoreline upwelling or downwelling in Lake Washington. While sockeye spawning locations have been mapped by WDFW, very little beach spawning has been documented in recent years. Shoreline hardening and the lack of erodible soils and subsequent sediment drift has likely resulted in a negative impact to shoreline upwelling/downwelling conditions.

   Structural complexity in Lake Washington currently consists of submerged aquatic macrophytes, some small and large woody debris primarily located along undeveloped shorelines, and piers or other man-made in-water structures. The lake is generally lacking in structural complexity relative to natural shorelines. The implications for juvenile salmonids are that the present lack of complex structure throughout most of Lake Washington provides an advantage to large predatory fish.

Substrate composition throughout Lake Washington is influenced by shoreline hardening, which restricts erosional sediment input. Without supplemental substrate to cover and replace contaminated areas, exposed areas with high levels of PCBs and PAHs may be available to impact the aquatic food chain. Although not specifically studied in Lake Washington, immunosuppression responses have been observed in salmonids migrating through similar Puget Sound urban areas (Arkoosh et al. 1998). Lake Washington was on the U.S. EPA 1998 303(d) list for sediment bioassay at one location near the mouth of May Creek in Renton, and the 2004 303(d) list of PCBs for one location near the north end of Lake Washington. While these locations are not specifically along the Town's shoreline, they are within the same waterbody and can affect the aquatic food chain lake-wide. Thus, discussion of water quality impacts, especially those derived by human causes, is warranted.

4. Shoreline Conditions: The urbanization of the Lake Washington shoreline has resulted in a shoreline generally lacking native vegetation. There are very few sources of woody debris recruitment that remain and these are primarily associated with the only remaining undeveloped shorelines. The result is a lack of habitat structure used for rearing and outside inputs necessary to support foraging. Juvenile salmonids primarily feed on aquatic and terrestrial invertebrates. The lack of overhanging and emergent vegetation limits outside inputs of naturally occurring nutrients and food resources.

   Shoreline modifications and nearshore structures around Lake Washington have dramatically altered the lake's aquatic ecosystem. Although some changes in the Lake environment are not completely understood, the effects of physical modifications to shoreline habitats on some aquatic species, particularly Chinook salmon, have been very well studied. Because of their sensitivity to changes in the aquatic ecosystem, anadromous salmonids are commonly used as a biological indicator species for the aquatic health of Lake Washington. There are many indigenous aquatic species inhabiting Lake Washington, but salmonids are one of the most sensitive. Due to their "threatened" status under the ESA, funding and other resources have been made available for the study of Chinook salmon utilizing Lake Washington, which are an important part of the Puget Sound Chinook Salmon Evolutionary Significant Unit (ESU). The life history pattern and habitat requirements of the Chinook salmon reflects the needs of other salmonid and non-salmonid aquatic species indigenous to Lake Washington, and information concerning the Chinook salmon serves

as a good proxy for other species in the Lake. Similarly, habitat restoration efforts designed to benefit Chinook or other salmonids will also be beneficial for other native species inhabiting Lake Washington.

Common modifications to nearshore aquatic habitats around much of Lake Washington include 1) the construction of bulkheads, which result in the structural simplification of shoreline habitats, and 2) the construction of piers, which block sunlight and create large areas of overhead cover within the nearshore littoral zone. These types of structural modifications to shorelines are now known to benefit non-native predators (like largemouth and smallmouth bass), while reducing the amount of complex aquatic habitat formerly available to salmonids rearing and migrating through Lake Washington (Kahler et al. 2000; Kerwin 2001; Tabor et al. 2006). Adult salmonids tend to utilize deepwater habitats in Lake Washington and structural changes to nearshore habitats typically have a lesser affect on adults than they do on juvenile salmonids. Lake Washington serves as an important rearing area and migration corridor for juvenile salmonids, however, and due to their affinity to nearshore, shallow-water habitats, juvenile salmonids are greatly affected by physical changes at the shoreline.

4.1.4 Anadromous Fish in the Lake Washington Watershed.

Adult Chinook salmon migrate from Puget Sound through the Chittenden Locks and into Lake Washington between July and September, continuing on to various tributary streams where they spawn in October and November. Although most Chinook salmon production in the Lake Washington watershed occurs in the Cedar River, the North Lake Washington tributary streams (feeding into the Sammamish River), or at the Issaquah Fish Hatchery, Chinook salmon (as well as coho and sockeye) also use many other, smaller Lake Washington tributary streams such as Kelsey Creek, Juanita Creek, and Thornton Creek. Chinook fry emerge from their redds between January and March, and either rear in their natal stream or emigrate to Lake Washington for a rearing period extending from three to five months. Emigrating through the Chittenden Locks and into Puget Sound between May and August, juvenile Chinook salmon leave the Lake Washington system during their first year (Kerwin 2001; Tabor and Piaskowski 2002). Other anadromous salmonids spawning and/or rearing in the Lake Washington watershed include sockeye salmon, coho salmon, steelhead trout, coastal cutthroat trout, and possibly bull trout.

After emerging from the gravel, Chinook fry from Lake Washington tributaries either emigrate directly to the Lake, or rear to the fingerling stage in their natal stream before entering the Lake (Seiler et al. 2005). This process occurs between

February and June. After they enter Lake Washington, juvenile Chinook often congregate near the mouths of tributary streams, and prefer low gradient, shallow-water habitats with small substrates (Tabor and Piaskowski 2002; Tabor et al. 2004b; Tabor et al. 2006). Chinook fry entering Lake Washington early in the emigration period (February and March) are still relatively small, typically do not disperse far from the mouth of their natal stream, and are largely dependent upon shallow-water habitats in the nearshore littoral zone with overhanging vegetation and complex cover (Tabor and Piaskowski 2002; Tabor et al 2004b). The mouths of creeks entering Lake Washington (whether they support salmon spawning or not), as well as undeveloped lakeshore riparian habitats associated with these confluence areas, attract juvenile Chinook salmon and provide important rearing habitat during this critical life stage (Tabor et al. 2004b; Tabor et al. 2006). Later in the emigration period (May and June), most Chinook juveniles have grown to fingerling size and begin utilizing offshore limnetic areas of the Lake more heavily. As the juvenile Chinook salmon mature to fingerlings and move offshore, their distribution extends throughout Lake Washington.

4.1.5 The Effects of Overwater Shading and Shoreline Armoring.

Piers and other overwater structures shade the lake bottom and affect the size, density, and species composition of aquatic plants living directly beneath them (Fresh and Lucchetti 2000). The magnitude of this effect on aquatic macrophytes varies with the size (square footage) of the structure and the amount of sunlight it blocks. Changes in the physical structure of the aquatic plant community affect juvenile salmonids, as well as other indigenous fishes that use this vegetation in the nearshore environment. Spatial heterogeneity in aquatic vegetation increases the amount of edge habitat, improving the quality of foraging habitat available to ambush predators like the bass (Bryan and Scarnecchia 1992; Weaver et al 1997; Kahler et al. 2000). The combined effect of an overwater structure and a dramatic change in aquatic vegetation results in a behavior modification in juvenile salmonids moving through both littoral and limnetic habitats. Juvenile salmonids migrating parallel to the shoreline will often change course to circumvent large piers or other overwater structures rather than swimming beneath them (Tabor and Piaskowski 2002; Tabor et al. 2004b; Tabor et al. 2006). These behavior modifications disrupt natural patterns of migration and can expose juvenile salmonids to increased levels of predation. Minimizing overwater coverage and associated support structures will benefit salmon fry rearing in the nearshore zone by reducing available predator habitat. It may also benefit older salmon fingerlings during migration out of the lake, by reducing shade levels, thereby reducing migration impacts. Studies related to shading effects from varying types of pier decking indicate that grated decking provides significantly more light to the water surface than traditional decking

methods and may lead to improved migratory conditions for juvenile Chinook salmon (Gayaldo and Nelson 2006).

Bulkheads or other types of shoreline armoring affect juvenile salmonids by eliminating shallow-water refuge habitat, or indirectly, by the elimination of shoreline vegetation and in-water woody debris that generally accompanies bulkhead construction. Placing bulkheads waterward of OHWM creates an abrupt, deep-water drop-off at the shoreline while eliminating shallow water habitat in the nearshore. Lange (1999) found that bank stabilization (i.e., various forms of erosion control structures that we refer to as "bulkheads") was negatively correlated to fish abundance and species richness at all spatial scales investigated. Juvenile Chinook salmon and other small fishes rely on shallow-water habitats in the littoral zone for foraging, refuge, and migration (Collins et al. 1995; Tabor and Piaskowski 2002). Shoreline armoring and bulkheads are also known to result in local reductions to the species diversity and abundance of both the fish community as well as the macroinvertebrate population inhabiting the littoral zone (Schmude et al. 1998; Lange 1999; Jennings et al. 1999).

4.1.6 Predator-Prey Interactions in Lake Washington

Indigenous Lake Washington fish species that prey on juvenile salmonids include cutthroat trout, rainbow trout, coho salmon, northern pikeminnow, five species of sculpin, and lamprey. Non-native predators currently present in the Lake include smallmouth bass, largemouth bass, and yellow perch. Native cutthroat trout populations (adfluvial and anadromous) are strong in Lake Washington, and this species is currently considered the primary predator of juvenile Chinook, sockeye, and coho salmon. Smaller-sized cutthroat trout prey on juvenile salmonid fry inhabiting the littoral zone early in the spring, while larger individuals feed on salmonid fingerlings migrating and rearing in the limnetic zone later in the season (Nowak et al. 2004; Tabor et al 2004a). A small proportion of northern pikeminnow, yellow perch, and smallmouth bass reside in nearshore regions during winter, but the majority moves offshore in the spring as temperatures in nearshore areas warm (Bartoo 1972; Olney 1975; Coutant 1975). The distributions of these fishes overlap primarily with the peak out-migration of Chinook through the littoral zone, whereas the overlap of cutthroat and Chinook distributions is continuous. Sculpins are present in the littoral zone year-round and are also known to eat juvenile Chinook salmon (Tabor et al. 1998; Tabor et al 2004a). In mid-summer, temperatures in the littoral zone become undesirable for juvenile Chinook and coho salmon, and the majority leave the lake or seek cooler temperatures away from the littoral zone, thus segregating themselves from littoral predators, but remaining vulnerable to cutthroat trout and potentially prickly sculpin.

The habitat requirements and behavior patterns of both bass species have been studied extensively throughout their range, including Lakes Washington and Sammamish. A growing body of bass-related research has collectively demonstrated that bass of both species have an affinity for structural elements, and that bass prey on juvenile salmonids in Lake Washington. Smallmouth bass are more abundant in Lake Washington than largemouth bass, but both species are present in the system.

Although smallmouth and largemouth bass are known to prefer natural cover types like brush, logs, aquatic vegetation, or boulders (Stein 1970), these adaptive species readily utilize floating docks and the support piles of piers in the absence of natural cover types. Artificial structures and cover types that promote shade or darkness are frequently favored by yearling bass of both species (Haines and Butler 1969; Bassett 1994). Bass of both species are also known to select low-gradient, shallow-water (0.6-1.5 meters), silty to gravelly habitats near structural features for spawning (Pflug 1981; Heidinger 1975; Allan and Romero 1975), and prefer similar habitat types near cover while foraging or resting (Vogele and Rainwater 1975). Although the habitat preferences of largemouth and smallmouth bass are generally similar, smallmouth bass generally select drop-offs or outcroppings, cover in the form of logs or rocks, and hard substrates without aquatic vegetation (Pflug 1981; Pflug and Pauley 1984), whereas largemouth bass generally prefer softer-bottom substrates and aquatic macrophytes (Coble 1975). These aspects of bass ecology are consistent with observations of bass behavior from across their geographic range (Bryan and Scarnecchia 1992; Kraai et al. 1991; Bassett 1994).

Logs, brush, or other pieces of large wood are rare along developed sections of the Lake Washington shoreline. Piers provide alternative sources of shade, overhead cover, and in-water structure (piles and boatlifts) that attract bass (Fresh et al. 2003). Piers and piles differ from natural cover/structure elements, such as brush piles, primarily in their lack of structural complexity. This difference is critical for prey fish, which rely on structural complexity for avoidance cover in the presence of predators. In developed lakes, piers become the dominant structural features, at the expense of natural complex structures such as woody debris and emergent vegetation (Bryan and Scarnecchia 1992; Poe et al. 1986; Lange 1999). In areas of Lake Washington where smallmouth bass are present, they preferentially select habitats beneath piers and near in-water support pilings (Fresh et al. 2003). Lake Washington smallmouth concentrations tend to be highest around large docks extending over deeper water, equipped with skirting and numerous support piles. Management plans designed to minimize any advantage non-native predators hold over juvenile salmonids in the littoral zone of Lake Washington should also seek to minimize the amount of overwater cover and support structure associated with pier or dock projects along the shoreline.

Shoreline development could potentially increase the rate of predation on juvenile salmonids by several principal means: 1) reducing the amount of refuge habitat available to prey species like juvenile salmonids by modifying the structure of the shoreline; 2) providing concealment structures for ambush predators such as bass and sculpin; 3) providing artificial lighting that allows for around-the-clock foraging by predators; and 4) altering migration routes for smolts and rearing fry. Although many predators that feed on juvenile salmonids are active, cruising hunters (i.e., other salmonids, piscivorous birds, northern pikeminnow), smallmouth and largemouth bass generally utilize ambush or habituation foraging strategies (Hobson 1979). Fayram and Sibley (2000) determined that smallmouth bass in Lake Washington occupied littoral home ranges that radiated 100 to 200 meters from the focal point and generally did not extend below 8-meter depths. Because of their propensity for ambush foraging and shoreline orientation, bass in Lake Washington benefit from artificial structures placed in the littoral zone, whereas yellow perch are more likely to utilize "non-structural" areas (Paxton and Stevenson 1979). Increased usage of complex cover (e.g., aquatic vegetation, woody debris, substrate interstices, and undercut banks) by prey fishes in the presence of predators, and reduced foraging efficiency of predators due to habitat complexity has been well documented (Wood and Hand 1985; Werner and Hall 1988; Bugert and Bjornn 1991; Tabor and Wurtsbaugh 1991; Persson and Eklov 1995).

Juvenile salmonids, like many other prey species, modify their behavior in the presence of predators by seeking or orienting to complex refuge (Gregory and Levings 1996; Reinhardt and Healey 1997), emigrating from areas with predators (Bugert and Bjornn 1991), aggregating (Tabor and Wurtsbaugh 1991), and moving to different elevations in the water column throughout the day and night (Eggers et al. 1978). Complex habitat features that exclude predators, physically or through risk-aversion can function as prey refuge. Examples of effective prey refuge include complex substrate, aquatic and emergent vegetation, overhanging terrestrial vegetation, undercut banks, and submerged pieces of large wood. Shallow water also functions as a refuge from predation for small fish, especially in the absence of complex habitat features such as woody debris or submerged vegetation.

Historically, Lake Washington's riparian and littoral zones were well vegetated, and interspersed with an abundance of large wood that had fallen along the shoreline (Evermann and Meek 1897; Stein 1970). The lowering of the Lake Washington water level and substantial shoreline development eliminated much of the vegetation and structural complexity historically available to juvenile salmonids rearing and migrating in the nearshore. Management plans seeking to encourage healthy assemblages of native fish should avoid the simplification of shoreline habitat, and the reduction of refuge-habitat for prey species.

Although the magnitude of avian predation in Lake Washington is unknown, piscivorous birds are present and this source of predation must be considered among potential threats to most fish, including juvenile salmonids. Common mergansers are abundant in the spring. Double-crested cormorants are common in Lake Washington, typically perching on the log booms at Union Bay and May Creek rather than on docks and bulkheads. Cormorants also commonly perch on individual piles. Western grebes inhabit enclosed bays (and some marinas), and forage throughout the lakes on calm days. Gulls are common, perching on log booms and on low docks, and are also known to feed on juvenile salmonids (Ruggerone 1986). In-water structures provide perching platforms for avian predators, from which they can launch feeding forays or dry plumage (Kahler et al. 2000). Incorporating anti-perching devices and grating in the design of overwater piers or related structures would work to minimize any advantage these structures convey to piscivorous birds.

4.2 Analysis of Ecological Functions

Ecological processes and functions of the Town of Beaux Arts Village's waterfront shoreline area is summarized below in Table 4. The table is organized around the Department of Ecology's list of processes and functions for freshwater lakes. The list includes the evaluation of three major process/function groups: 1) hydrologic; 2) vegetation; and 3) habitat. These are further broken down into the following functions which are in turn used to evaluate performance:

Lake Functions
1. Hydrologic Functions • Storing water and sediment • Attenuating wave energy • Removing excess nutrients and toxic compounds • Recruitment of large woody debris (LWD) and other organic material
2. Vegetative Functions • Temperature regulation • Water quality improvement • Attenuating wave energy • Sediment removal and bank stabilization • LWD and organic matter recruitment
3. Habitat Functions • Physical space and conditions for life history • Food production and delivery

Assessment of each function is based upon both quantitative data results derived from the GIS inventory information described in Chapter 3, and a qualitative assessment based on aerial photography, field inventory (where possible), and existing assessment information.

4.2.1 Assessment Area 1 - WABA Results

Assessment Area 1 is depicted in Exhibits 3 through 5. It includes all shoreline jurisdiction located within the WABA open space parcel. The entire parcel includes 1,146 feet of shoreline and is approximately 4.35 acres in size, of which only a small area (approximately 0.06 acre) located at the terminus of SE 28th Street is not in shoreline jurisdiction. The parcel is zoned Open Space Land and has been set aside for preservation as recreational land. The northeast corner of the parcel is occupied by an artesian well, which supplies the Town with water. Aerial oblique photographs (Exhibits 3 through 5) are from Ecology (taken in 2007) and show land use, cover, and general shoreline condition.

Exhibit 3. Northernmost extent of Assessment Area 1 – WABA parcel.

Exhibit 4. Assessment Area 1 – WABA parcel.

Exhibit 5. Southernmost extent of Assessment Area 1 – WABA parcel.

Table 4. Function Summary of Beaux Arts Village Assessment Area 1

Shoreline Processes and Functions Occurring within Assessment Area	Alterations and Assessment of Functions
Ecosystem process: Water movement (wave energy); sediment movement (inputs, deposition and loss); shoreline erosion; movement of woody debris; organic inputs from shoreline. **Shoreline functions:** Water quantity – no significant discharges of surface waters Water quality – temperature regulation performed by some riparian vegetation, nutrient removal (denitrification), sediment transport, and toxicant removal. Habitat - consists of shoreline habitats. Specifically, this area contains habitat structure and complexity for plants, diatoms, fishes, birds, mammals and anadromous fish species, and terrestrial plants and animals.	This assessment area includes almost 100% of the WABA parcel; a small area of the WABA parcel extends just outside of shoreline jurisdiction. The shoreline is primarily comprised of rock bulkheads with some areas of exposed cobble or sand beaches in front of the bulkheads. Lawn grasses are located upland of the bulkhead throughout the shoreline with conifers at the water's edge in one location. The upland portions of the property are heavily forested and commonly known as "The Woodlands." One recreational pier and float and four multi-slip piers are located within this assessment area. An asphalt parking area/turnaround and boat launch are located along the northern boundary of the property. Approximately 5% of this assessment area is mapped as impervious (parking lot and tennis court). Approximately 86% of the assessment area has vegetative cover. 93% of the shoreline is armored with rock bulkheads, preventing the movement of sediments within the shoreline environment. Based on the amount of armoring, the limited presence of riparian vegetation along the water's edge, and the large amount of overwater cove, the current condition of Beaux Arts Village's shoreline has low ecological function.

4.2.2 Assessment Area 2 – Residential Results

Assessment Area 2 includes all shoreline jurisdiction located within upland residential parcels and a parcel owned by the water district east of the WABA open space parcel. Eleven parcels are included in this assessment area, along with small portions of three Town rights-of-way (SE 27th Street, SE 28th Place, and SE 29th Street). This assessment area is approximately 0.81 acres in size.

Ten of the lots are developed with single-family residences, and one lot is owned by Water District #22, which operates the water system for the Town. The Water District lot contains a pump house, which moves the water from the artesian well on the WABA parcel to the water tower at a high point in the Town outside of shoreline jurisdiction. All of the residences are buffered from the shoreline by significant trees located in the eastern portion of the WABA parcel. The closest residence is approximately 130 feet from the OHWM, but most of the residences are beyond 160 feet or are out of shoreline jurisdiction. Only 8.6% of this assessment area is impervious, with the remainder occupied by forested vegetation and some landscaping and lawn areas.

Because this Assessment Area is far removed from the water's edge, the performance of shoreline functions is limited. Primarily, the area expands on the terrestrial habitats of the upland forest on the WABA parcel and begins filtering any polluted runoff that that may originate on the residential parcels and areas outside of shoreline jurisdiction.

4.3 Shoreline Restoration Opportunities

4.3.1 Introduction

Ecology's *Shoreline Master Program Guidelines* (173-26 WAC) includes the following definition:

> "Restore," "Restoration" or "ecological restoration" means the reestablishment or upgrading of impaired ecological shoreline processes or functions. This may be accomplished through measures including but not limited to re-vegetation, removal of intrusive shoreline structures and removal or treatment of toxic materials. Restoration does not imply a requirement for returning the shoreline area to aboriginal or pre-European settlement conditions.

Consistent with Ecology's definition, use of the word "restore," or any variations, in this document is not intended to encompass actions that re-establish historic conditions. Instead, it encompasses a suite of strategies that can be approximately delineated into four categories: creation (of a new resource), restoration (of a converted or substantially degraded resource), enhancement (of

an existing degraded resource), and protection (of an existing high-quality resource).

There is a critical distinction between restoration and mitigation. Mitigation will require applicants whose shoreline proposals will have adverse impacts to complete actions to mitigate those impacts or provide compensation in other ways for losses of ecological function. The Town cannot require applicants to go beyond returning the impacted area (or compensating in other ways for lost functions) to the condition it was in at the time of this inventory or as further detailed at the time of application. However, the Town can encourage applicants to implement restoration actions that will improve ecological functions relative to the applicant's pre-project condition. As stated in WAC 173-26-201(2)(c):

> It is intended that local government, through the master program, along with other regulatory and nonregulatory programs, contribute to restoration by planning for and fostering restoration and that such restoration occur through a combination of public and private programs and actions. Local government should identify restoration opportunities through the shoreline inventory process and authorize, coordinate and facilitate appropriate publicly and privately initiated restoration projects within their master programs. The goal of this effort is master programs which include planning elements that, when implemented, serve to improve the overall condition of habitat and resources within the shoreline area of each city and county."

The *Salmon and Steelhead Habitat Limiting Factors Report for the Cedar-Sammamish Basin (Water Resource Inventory Area 8)* (Kerwin 2001) identifies the following five "limiting habitat factors and impacts on Lake Washington:"

- The riparian shoreline of Lake Washington is highly altered from its historic state. Current and future land use practices all but eliminate the possibility of the shoreline to function as a natural shoreline to benefit salmonids;

- Introduced plant and animal species have altered trophic interactions between native animal species;

- The known historic practices and discharges into Lake Washington have contributed to the contamination of bottom sediments at specific locations;

- The presence of extensive numbers of docks, piers and bulkheads have highly altered the shoreline; and
- Riparian habitats are generally non-functional.

4.3.2 Specific Opportunities

Except for a few residential properties at the upland perimeter of shoreline jurisdiction, the Town's shoreline jurisdiction is owned and managed by the Western Academy of Beaux Arts (WABA). All of the Town property owners are entitled to membership in WABA and have access to the property. In 2009, WABA received a grant from King Conservation District to conduct a habitat restoration master plan. The draft preferred alternative plan that has been developed includes elements that are consistent with general lake restoration needs identified by the WRIA 8 program. These elements include: 1) reduction or modification of shoreline armoring, 2) improvements to nearshore native vegetative cover (both terrestrial and aquatic), and/or 3) increases in shallow-water areas.

See Section 7.2 for discussion of how identified opportunities fit into the larger restoration strategy.

5 LAND USE ANALYSIS AND IMPLICATIONS

WAC 173-26-201(3)(d)(2) requires a shoreline use analysis to estimate the future demand for shoreline space and to identify future use conflicts. The Town does not anticipate future use conflicts, as the area is entirely developed and no changes in land use patterns are projected or desired by local residents in and outside of shoreline jurisdiction.

5.1 Residential Development

The Town of Beaux Arts Village is fully developed as a residential community. With the exception of the WABA shoreline area and two Water District #22 parcels, each property in the Town is developed with a single-family residence. Occasionally, a residential lot may become vacant as an older home is removed and a newer, larger home is planned and eventually constructed. All residential property owners have the option to become members of the Western Academy of Beaux Arts (WABA), and thus have use of the shoreline area, including swimming beaches, recreational facilities, and moorage piers.

The residences that fall within shoreline jurisdiction are set back a minimum of 130 feet, with an average of 160 feet. A total of ten residential lots fall within the

shoreline jurisdiction. Coupled with the zoning restrictions for residential development (25' rear setback; 10' side setback; maximum 35% lot coverage), the open space adjacent to the water's edge provides a buffer that helps to maintain shoreline function.

5.2 Utilities

The City of Bellevue operates a sanitary sewer line that passes through the WABA shoreline property. A study is currently underway by the City of Bellevue Utilities Department to evaluate the condition of the sewer line, with the goal of (1) identifying any sections requiring immediate repair or replacement and (2) developing a management plan for the next several decades of sewer capital improvements.

Water District #22 operates the potable water system in Beaux Arts; the City of Bellevue provides back up during times the system is down. The District operates two wells located within the shoreline jurisdiction area, at the north end of the Town. The water is pumped to a site approximately one-half mile upland from the shoreline, and the residents are served via a gravity flow system.

5.3 WABA

The Western Academy of Beaux Arts, a private entity with membership open to all property owners within the Town of Beaux Arts Village, provides recreational opportunities for Town residents. The WABA shoreline area includes the following amenities: swimming beaches, moorage facilities, tennis court, picnic areas, fire/barbeque pits, play equipment, lawn, forested areas, and walking trails. The property is managed by a Board elected by the WABA members. While the primary purpose and uses of the site are not expected to change, WABA is currently planning a variety of shoreline habitat improvements.

5.4 Shoreline Designations

The Department of Ecology, in accordance with WAC 173-26-211, has directed that shoreline areas be classified as one of six specific shoreline designations, based on the existing land use patterns, the biological and physical character of the shoreline, and the goals of the community as expressed through the Comprehensive Plan. The six suggested designations include Natural, Rural Conservancy (not suited for incorporated areas), Aquatic, High Intensity, Urban Conservancy, and Shoreline Residential, with the following purposes:

Natural Environment: to protect those shoreline areas that are relatively free of human influence or that include intact or minimally degraded shoreline functions intolerant of human use. These systems require that only very low intensity uses be allowed in order to maintain the ecological functions and ecosystem-wide processes. Consistent with the policies of the designation, local

government should include planning for restoration of degraded shorelines within this environment.

Aquatic Environment: to protect, restore, and manage the unique characteristics and resources of the areas waterward of the ordinary high-water mark.

High Intensity Environment: to provide for high-intensity water-oriented commercial, transportation, and industrial uses while protecting existing ecological functions and restoring ecological functions in areas that have been previously degraded.

Urban Conservancy Environment: to protect and restore ecological functions of open space, flood plain and other sensitive lands where they exist in urban and developed settings, while allowing a variety of compatible uses.

Shoreline Residential Environment: to accommodate residential development and appurtenant structures that are consistent with this chapter. An additional purpose is to provide appropriate public access and recreational uses.

The designations appropriate for Beaux Arts may include Urban Conservancy for Assessment Area 1 and Residential for Assessment Area 2.

6 PUBLIC ACCESS ANALYSIS AND IMPLICATIONS

The entire Beaux Arts shoreline is owned by the Western Academy of Beaux Arts (WABA). This nonprofit entity, with membership open to property owners within the Town of Beaux Arts Village, manages all aspects of the property through its elected Board of Directors. Because the entire shoreline of the town is in WABA ownership, the Beaux Arts public has full access to Lake Washington. No changes to public access are anticipated.

In 2010, WABA was awarded a grant from King Conservation District (KCD) to develop a habitat restoration plan for the shoreline area. This study is currently underway. The ongoing development of the plan has involved extensive community outreach, with an emphasis of combining increased habitat areas and recreational opportunities. A stipulation of the grant is that the plan and its implementation serve as a model for other property owners/jurisdictions that are attempting extensive shoreline restoration projects. Following installation of the shoreline restoration improvements, the property will be open to the general public on specific dates, as required by KCD.

7 SHORELINE MANAGEMENT RECOMMENDATIONS

The following are recommended actions for translating inventory and characterization findings into the draft SMP policies, regulations, environment designation boundaries, and restoration strategies for areas within the shoreline jurisdiction. In addition to the recommendations included below derived from analysis in Chapters 1 through 6, the Town's current regulations, such as the existing Shoreline Management Ordinance (Nos. 89 and 100) and the Wetlands Ordinance (No. 233), will be reviewed for adequacy under the Shoreline Master Program Guidelines requirements. Where existing regulations fulfill either the recommendations provided below or a standard in the Shoreline Management Act or Shoreline Master Program Guidelines, the existing language or concepts would be considered for incorporation into the updated SMP.

The following recommendations are not suggested SMP language.

7.1 Shoreline Master Program

7.1.1 Shoreline Environment Designation Provisions

- The current environment designation for the entirety of the Town's shoreline is Conservancy. It is recommended that the Town utilize Ecology's recommended environment designations as appropriate.

- Consider the Shoreline Residential designation for those lots located outside of the WABA parcel (Assessment Area 2). These areas constitute 15.9 percent of the shoreline area.

- Consider the Urban Conservancy or a similar locally equivalent designation for the WABA parcel. This area constitutes 84.1 percent of shoreline jurisdiction. This designation would reflect the continued management priorities of providing water-dependent and water-enjoyment shoreline access.

7.1.2 General Policies and Regulations

Critical Areas

- Consider whether the Town's Wetlands Ordinance (No. 233) should be incorporated into the SMP by reference or through direct inclusion. Consideration should be given to the Town's ability to manage changes to the regulations as needed in the future. Incorporation of the Wetlands Ordinance into the SMP as an appendix would enable the Town greater

flexibility to modify the regulations as they apply outside of shoreline jurisdiction, while retaining the need for Ecology's approval only to those regulations that apply in the shoreline jurisdiction.

Shorelines of Statewide Significance

- Lake Washington is a Shoreline of Statewide Significance and the SMP should incorporate the priorities of RCW 90.58.020 in the SMP policies.

- Corridors for migrating listed salmon species, habitat restoration and water quality improvements are in the broader statewide interest. The Town should give priority to these shoreline functions to be consistent with policies for Shoreline of Statewide Significance.

- In managing the shoreline area, the Town should evaluate regulations that:

  - Preserve the natural character of the shoreline to the extent possible;
  - Seek long term over short term benefits to the shoreline area;
  - Protect resources and ecology of the shoreline area; and,
  - Increase public access and recreational opportunities along the shoreline. (WAC 173-26-251)

Public Access

- The Town is in the unique position of having all of its waterfront and most of its shoreline jurisdiction accessible to all of its residents for water-dependent and water-enjoyment uses through membership in WABA. As described in Sections 5 and 6, the property offers passive and active recreational opportunities through boating, swimming, and nature trails.

Vegetation Conservation

- As noted, presence of native vegetation along the boundary between the land and the lake is very limited. Conservation of existing native vegetation and reestablished of native vegetation is critical to maintaining the ecological processes and natural functions of shoreline areas. Vegetation conservation provisions should be crafted to emphasize retention of existing native vegetation and any existing non-native trees where present, as well as encourage, through policies and/or regulation, establishment of native riparian vegetation.

- Include provisions which encourage the protection and enhancement of the ecological functions of the shoreline, while still providing public recreation opportunities to the lake.

Water Quality, Storm Water, and Nonpoint Pollution

- The Town currently reviews all development applications for compliance with the latest King County/Ecology stormwater management manual. The SMP should include appropriate regulatory references to the manual, requirements for use of appropriate materials in and over the water, and consideration of policies and/or regulations limiting upland use of chemical (pesticides/herbicides).

7.1.3 Shoreline Modification Provisions

Shoreline Stabilization

- Ensure "replacement" and "repair" definitions and standards are consistent with WAC 173-26-231(3)(a). Repair activities should be defined to include a replacement threshold so that applicants and staff will know when "replacement" requirements need to be met.

- Explore a range of solutions to reduce the amount of shoreline armoring over time along the shoreline. Consistent with requirements of the Shoreline Master Program Guidelines, alternative methods to protect shorelines from erosion using native vegetation, strategically placed logs and boulders, and other materials should be investigated.

- Consider prohibiting new shoreline stabilization structures. Rather, consider requiring the planting of riparian vegetation along all or a portion of the shoreline immediately landward of the OHWM, as well as the installation of a gravel/cobble beach fill waterward of the OHWM.

Piers and Docks

- There is no potential in the Town's shoreline jurisdiction for private single-family pier or dock development given the current ownership. Five community docks are located within the Town.

Fill

- As directed by the Shoreline Master Program Guidelines, provide appropriate limitations on placement of fill in shoreline areas, including areas waterward of the ordinary high water mark. Fill should be limited to shoreline restoration projects.

- Restoration fills should be encouraged, including improvements to shoreline habitats, material to anchor large woody debris placements, and as needed to implement shoreline restoration.

Breakwaters, Jetties, Groins and Weirs

- Regulations should be developed consistent with the State's Shoreline Master Program Guidelines, and consideration given to prohibiting some or all of these modifications.

Dredging and Dredge Material Disposal

- The State's Shoreline Master Program Guidelines are fairly detailed with regard to establishing the framework and details of dredging regulations. The need for dredging in the Town is likely fairly limited. Allowed dredging should be limited to shoreline restoration projects.

Shoreline Habitat and Natural Systems Enhancement Projects

- To the maximum extent feasible, the SMP should include provisions and incentives to encourage restoration projects, particularly in areas identified as having low function. Emphasize that certain fills can be an important component of some restoration projects, particularly for armoring improvements.

7.1.4 Shoreline Uses

Boating Facilities

- Develop appropriate standards for community access-related overwater structures.

- Provide clear dimensional and other standards for certain elements of boating facilities.

- Consider standards that address incorporating materials such as grated decking for dock and pier replacements/modifications that may be proposed in the future along the shoreline.

- Pier regulations should be consistent with Washington Department of Fish and Wildlife design standards, and recognize special local issues or circumstances.

- New and modified docks and piers should be sited, designed and constructed as environmentally sensitive examples for the community to follow.

- Require replacement of nearshore decking with grated decking equivalent in size to the additional surface coverage associated with pier additions or other over- or in-water structures.

- Consider prohibiting new covered moorage structures. Boat lifts and canopies should be allowed as alternatives.

Recreational Development

- Incorporate policies and regulations which support the operation of existing and development of future recreational opportunities within the shoreline area. This should include opportunities for increased disabled access.

- Continue to encourage boat launch facilities for small, non-motorized craft.

Residential Development

- Include a policy regarding education of homeowners about the use of fertilizers and chemicals and encourage natural lawn care and landscaping methods to reduce chemical output into downslope shorelines.

Nonconformance

- Continue to evaluate any proposed building improvements for nonconforming residential structures through the Town's Zoning Code Ordinance.

Transportation and Parking

- Additional parking areas, if proposed, should be located outside of shoreline jurisdiction whenever feasible, or utilize the latest pervious materials.

- Roads, driveways and parking areas should be targeted for stormwater quality facilities during significant additions or redevelopment.

Utilities

- Create regulations that differentiate between primary (or major) utilities and those minor utilities intended to provide local service connections. Additional restrictions should be placed on primary (or major) utilities such as trunk sewer lines, transmission lines, etc.

- Include provisions for utility repairs and maintenance in shoreline jurisdiction.

- Stormwater regulations and capital facility projects should emphasize maintaining and improving the water quality of discharges to Lake Washington.

7.2 Restoration Plan

7.2.1 Introduction

The Shoreline Restoration Plan must address the following six subjects (WAC 173-26-201(2)(f)(i-vi)) and incorporated findings from this analysis report:

(i) Identify degraded areas, impaired ecological functions, and sites with potential for ecological restoration;

(ii) Establish overall goals and priorities for restoration of degraded areas and impaired ecological functions;

(iii) Identify existing and ongoing projects and programs that are currently being implemented, or are reasonably assured of being implemented (based on an evaluation of funding likely in the foreseeable future), which are designed to contribute to local restoration goals;

(iv) Identify additional projects and programs needed to achieve local restoration goals, and implementation strategies including identifying prospective funding sources for those projects and programs;

(v) Identify timelines and benchmarks for implementing restoration projects and programs and achieving local restoration goals; and

(vi) Provide for mechanisms or strategies to ensure that restoration projects and programs will be implemented according to plans and to appropriately review the effectiveness of the projects and programs in meeting the overall restoration goals.

The Restoration Plan will "include goals, policies and actions for restoration of impaired shoreline ecological functions. These master program provisions should be designed to achieve overall improvements in shoreline ecological functions over time, when compared to the status upon adoption of the master program." The Restoration Plan will mesh potential projects identified in this report with additional projects, regional or Town-wide efforts, and programs of the Town, WABA, watershed groups, and environmental organizations that contribute or could potentially contribute to improved ecological functions of the shoreline. In particular, the final WABA shoreline restoration design will be discussed in greater detail in the Shoreline Restoration Plan.

7.2.2 WRIA 8

The Town was one of 27 members of the WRIA 8 Forum, which participated in financing and developing the *Final Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan*. The *Chinook Salmon Conservation Plan* includes the Town of Beaux Arts Village's Resolution No. 220, ratifying the plan,

dated 15 July 2005. The following is a list of general objectives for Lake Washington that are part of the WRIA 8 Action Start-List.

Reduce predation to outmigrating juvenile Chinook by: reducing bank hardening, restoring overhanging riparian vegetation, replacing bulkhead and rip-rap with sandy beaches with gentle slopes, and use of mesh dock surfaces and/or community docks.

- Encourage salmon friendly shoreline design during new construction or redevelopment by offering incentives and regulatory flexibility to improve bulkhead and dock design and revegetate shorelines.

- Increase enforcement and address nonconforming structures over long run by requiring that major redevelopment projects meet current standards.

- Discourage construction of new bulkheads; offer incentives (e.g., provide expertise, expedite permitting) for voluntary removal of bulkheads, beach improvement, riparian revegetation.

- Support joint effort by NOAA Fisheries and other agencies to develop dock/pier specifications to streamline federal/state/local permitting; encourage similar effort for bulkhead specifications.

- Promote value of light-permeable docks, smaller piling sizes, and community docks to both salmon and landowners through direct mailings to lakeshore landowners or registered boat owners sent with property tax notice or boat registration tab renewal.

- Offer financial incentives for community docks in terms of reduced permit fees, loan fees/percentage rates, taxes, and permitting time, in addition to construction cost savings.

- Develop workshop series specifically for lakeshore property owners on lakeside living: natural yard care, alternatives to vertical wall bulkheads, fish friendly dock design, best management practices for aquatic weed control, porous paving, and environmentally friendly methods of maintaining boats, docks, and decks.

Protect and restore water quality in tributaries and along shoreline. Restore coho runs in smaller tributaries as control mechanism to reduce the cutthroat population. Reconnect and enhance small creek mouths as juvenile rearing areas.

- Address water quality and high flow impacts from creeks and shoreline development through NPDES Phase 1 and Phase 2 permit updates, consistent with Washington Department of Ecology's 2001 Stormwater Management Manual, including low impact development techniques, on-

site stormwater detention for new and redeveloped projects, and control of point sources that discharge directly into the lakes.

- Encourage low impact development through regulations, incentives, education/training, and demonstration projects.

- Protect and restore water quality and other ecological functions in tributaries to reduce effects of urbanization and reduce conditions which encourage cutthroat. Protect and restore forest cover, riparian buffers, wetlands, and creek mouths by revising and enforcing critical areas ordinances and Shoreline Master Programs, incentives, and flexible development tools.

- Promote through design competitions and media coverage the use of "rain gardens" and other low impact development practices that mimic natural hydrology.

Many of the planning-level items listed above, if applicable, should be considered part of Chapter 7, Shoreline Management Recommendations. Other items will be addressed in greater detail in the Shoreline Restoration Plan.

8 REFERENCES

Allan, R.C. and J. Romero. 1975. Underwater observations of largemouth bass spawning and survival in Lake Mead. Pages 104-112 *in* H. Clepper, ed. Black Bass Biology and Management. Sport Fishing Institute, Washington, DC. 534 p.

American Forests. 1998. Regional Ecosystem Analysis Puget Sound Metropolitan Area: Calculating the Value of Nature.

Arnold, Jr., C.L. and C.J. Gibbons. 1996. Impervious surface coverage: the emergence of a key environmental indicator. Journal of the American Planning Association 62(2): 243-258.

Bartoo, N.W. 1972. The vertical and horizontal distributions of northern squawfish (*Ptychocheilus oregonensis*), peamouth (*Mylocheilus caurinus*), yellow perch (*Perca flavescens*), and adult sockeye salmon (*Oncorhynchus nerka*) in Lake Washington. M.S. Thesis, Univ. of Washington, Seattle, WA. 60 p.

Bassett, C.E. 1994. Use and evaluation of fish habitat structures in lakes of the eastern United States by the USDA Forest Service. Bulletin of Marine Science 55: 1137-1148.

Booth, D. 1998. Are wild salmon runs sustainable in rehabilitated urban streams? In Abstracts from the Salmon in the City conference. Center for Urban Water Resources Management, University of Washington, Seattle, WA. 65 pp.

Bryan, M.D. and D.L. Scarnecchia. 1992. Species richness, composition, and abundance of fish larvae and juveniles inhabiting natural and developed shorelines of a glacial Iowa lake. Environmental Biology of Fishes 35:329-341.

Bugert, R. M. and T. C. Bjornn. 1991. Habitat use by steelhead and coho salmon and their responses to predators and cover in laboratory streams. Trans. Am. Fish. Soc. 120: 486-493.

Coble, D.W. 1975. Smallmouth bass. Pages 21-33 *in* H. Clepper, ed. Black Bass Biology and Management. Sport Fishing Institute, Washington, DC. 534 p.

Collins, N.C., P. St. Onge, V. Dodington, W. Dunlot, and N. Hutchinson. 1995. The importance to small fish of littoral fringe habitat (Z<0.2m) in unproductive lakes, and the impacts of shoreline development. Poster presented at the 15th Annual International Symposium of the North American Lake Management Society, 6-11 November 1995, Toronto, ON. 6 p.

Coutant, C.C. 1975. Responses of bass to natural and artificial temperature regimes. Pages 272-285 *in* H. Clepper, ed. Black Bass Biology and Management. Sport Fishing Institute, Washington, DC. 534 p.

Edmondson, W.T. 1991. The uses of Ecology: Lake Washington and Beyond. University of Washington Press, Seattle, WA.

Eggers, D.M., N.W. Bartoo, N.A. Rickard, R.E. Nelson, R.C. Wissmar, R.L. Burgner, and A.H. Devol. 1978. The Lake Washington ecosystem: the perspective from the fish community production and forage base. J. Fish. Res. Board Can. 35: 1553-1571.

Evermann, B.W. and S.E. Meek. 1897. A report upon salmon investigations in the Columbia River Basin and elsewhere on the Pacific Coast. Bulletin of the United States Fish Commission. 17: 15-84.

Fayram, A.H. and T.H. Sibley. 2000. Impact of predation by smallmouth bass on sockeye salmon in Lake Washington. N. Am. J. Fish. Manage. 20:81-89.

Fresh, K.L. and G. Lucchetti. 2000. Protecting and restoring the habitats of anadromous salmonids in the Lake Washington Watershed, an urbanizing ecosystem. Pages 525-544 in E.E. Knudsen, C.R. Steward, D.D. MacDonald, J.E. Williams, and D.W. Reiser (editors). Sustainable Fisheries Management: Pacific salmon. CRC Press LLC, Boca Raton.

Fresh, K.L., D. Rothaus, K.W. Mueller, and C. Waldbilig. 2003. Habitat utilization by smallmouth bass in the littoral zones of Lake Washington and Lake Union/Ship Canal. 2003 Greater Lake Washington Chinook Workshop, 2002 Update and Synthesis. January 24, 2003.

Frodge, J.D., D.A. Marino, G.B. Pauley, and G.L. Thomas. 1995. Mortality of largemouth bass (*Micropterus salmoides*) and steelhead trout (*Oncorhynchus mykiss*) in densely vegetated littoral areas tested using *in situ* bioassay. Lake and Reserv. Manage. 11: 343-358.

Gayaldo, P.F. and K. Nelson. 2006. Preliminary results of light transmission under residential piers in Lake Washington, King County, Washington: A comparison between prisms and grating. Lake and Reserv. Manage. 22(3):245-249.

Gregory, R.S. and C.D. Levings. 1996. The effects of turbidity and vegetation on the risk of juvenile salmonids, *Oncorhynchus* spp., to predation by adult cutthroat trout, *O. clarki*. Environmental Biology of Fishes. 47: 279-285.

Haines, T.A. and R.L. Butler. 1969. Responses of yearling smallmouth bass (*Micropterus dolomieui*) to artificial shelter in a stream aquarium. J. Fish. Res. Bd. Canada 26: 21-31.

Heidinger, R.C. 1975. Life history and biology of largemouth bass. Pages 11-20 *in* H. Clepper, ed. Black Bass Biology and Management. Sport Fishing Institute, Washington, DC. 534 p.

Hobson, E.S. 1979. Interactions between piscivorous fishes and their prey. Pages 231-242 *in*: H. Clepper, ed. Predator-prey Systems in Fisheries Management. Sport Fishing Institute, Washington, DC. 504 p.

Jennings, M.J., M.A. Bozek, G.R. Hatzenbeler, E.E. Emmons, and M.D. Staggs. 1999. Cumulative effects of incremental shoreline habitat modifications on fish assemblages in north temperate lakes. N. Am. J. Fish. Manage. 19: 18-27.

Kahler T., M. Grassley, and D. Beauchamp. 2000. A Summary of the effects of bulkheads, piers, and other artificial structures and shorezone development on ESA-listed salmonids in lakes. Final Report. Prepared for City of Bellevue by The Watershed Company. 74 pp.

Kerwin, J. 2001. Salmon and steelhead limiting factors report for the Cedar – Sammamish Basin (Water Resource Inventory Area 8). Washington Conservation Commission, Olympia, WA.

King County Department of Natural Resources. Basin and water quality information. http://dnr.metrokc.gov/wlr/waterres/lakes/LakeWashington.htm

King County Department of Natural Resources. Maps of salmon and trout distribution. http://dnr.metrokc.gov/wlr/waterres/lakes/ LakeWashington.htm

Kraai, J.E., C.R. Munger, and W.E. Whitworth. 1991. Home range, movements, and habitat utilization of smallmouth bass in Meredith Reservoir, Texas. Pages 44-48 *in* D. C. Jackson, ed. The First International Smallmouth Bass Symposium. 24-26 August 1989, Nashville, TN. Mississippi Agricultural and Forestry Experiment Station, Mississippi State Univ., Mississippi State, MS.

Lange, M. 1999. Abundance and diversity of fish in relation to littoral and shoreline features. M.S. Thesis. University of Guelph, Guelph, Ontario, Canada. 46 p. plus appendices.

Li, Kevin. *Unknown date.* The Lake Washington Story. Retrieved 16 November 2006, from King County Department of Natural Resources and Parks website. http://dnr.metrokc.gov/ wlr/waterres/lakes/biolake.htm

Malcom, R. Muckleshoot Indian Tribe. Personal communication, telephone conversation with Tom Kahler (The Watershed Company), 22 November 1999.

May, C.W., R.R. Horner, J.R. Karr, B.W. Marr, and E.B. Welch. 1997. Effects of urbanization on small streams in the Puget Sound Lowland Ecoregion. Watershed Protection Techniques 2(4): 483-494.

Nowak, G.M., R.A. Tabor, E.J. Warner, K.L. Fresh, and T.P. Quinn. 2004. Ontogenetic shifts in habitat and diet of cutthroat trout in Lake Washington, Washington. North American Journal of Fisheries Management 24:624-635.

Paxton, K.O. and F. Stevenson. 1979. Influence of artificial structures on angler harvest from Killdeer Reservoir, Ohio. Pages 70-76 *in* D.L. Johnson and R.A. Stein, *eds.* Response of fish to habitat structure in standing water. Special Publication 6, North Central Division, American Fisheries Society, Bethesda, MA, USA. 77 p.

Persson L. and P. Eklov. 1995. Prey refuges affecting interactions between piscivorous perch and juvenile perch and roach. Ecology 76: 70-81.

Pflug, D.E. 1981. Smallmouth bass (*Micropterus dolomieui*) of Lake Sammamish: a study of their age and growth, food and feeding habits, population size, movement and homing tendencies, and comparative interactions with largemouth bass. M.S. Thesis, Univ. of Washington, Seattle, WA. 80 p.

Pflug, D.E. and G.B. Pauley. 1984. Biology of smallmouth bass (*Micropterus dolomieui*) in Lake Sammamish, Washington. Northwest Science 58: 118-130.

Poe, T.P., C.O. Hatcher, C.L. Brown, and D.W. Schlosser. 1986. Comparison of species composition and richness of fish assemblages in altered and unaltered littoral habitats. J. Freshwat. Ecol. 3: 525-536.

Reinhardt, U.G. and M.C. Healey. 1997. Size-dependent foraging behavior and use of cover in juvenile coho salmon under predation risk. Can. J. Zool. 75: 1642-1651.

Ruggerone, G.T. 1986. Consumption of migrating juvenile salmonids by gulls foraging below a Columbia River dam. Trans. Am. Fish. Soc. 115: 736-742.

Seiler, D., G. Volkhardt, and L. Fleischer. 2005. Evaluation of downstream migrant salmon production in 2004 from the Cedar River and Bear Creek. Washington Department of Fish and Wildlife, Olympia, Washington.

Schmude, K.L., M.J. Jennings, K.J. Otis, and R.R. Piette. 1998. Effects of habitat complexity on macroinvertebrate colonization of artificial substrates in north temperate lakes. J. N. Am. Benthol. Soc. 17: 73-80.

Stein, J.N. 1970. A study of the largemouth bass population in Lake Washington. M.S. Thesis, Univ. of Washington, Seattle, WA. 69 p.

Tabor, R.A., M.T. Celedonia, F. Mejia, R.M. Piaskowski, D.L.Low, B. Footen, and L. Park. 2004. Predation of juvenile Chinook salmon by predatory fishes in three areas of the Lake Washington basin. Miscellaneous report. U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office, Lacey, Washington.

Tabor, R.A., H.A. Gearns, C.M. McCoy III, and S. Camacho. 2006. Nearshore habitat use by juvenile Chinook salmon in lentic systems of the Lake Washington Basin, Annual Report, 2003 and 2004. U.S. Fish and Wildlife Service, Lacey, WA.

Tabor, R.A. and W.A. Wurtsbaugh. 1991. Predation risk and the importance of cover for juvenile rainbow trout in lentic systems. Trans. Am. Fish. Soc. 120: 728-738.

The Watershed Company. 1999-ongoing. Biological Evaluations prepared for pier/bulkhead projects in Lake Washington.

Toft, J.D. 2001. Shoreline and dock modifications in Lake Washington. Prepared for King County Department of Natural Resources. October 2001. SAFS-UW-0106

Town of Beaux Arts Village. 2004. Town of Beaux Arts Village Comprehensive Plan.

Vogele, L.E. and W.C. Rainwater. 1975. Use of brush shelters as cover by spawning black basses (*Micropterus*) in Bull Shoals Reservoir. Trans. Am. Fish. Soc. 104: 264-269.

Washington Department of Archaeology and Historic Preservation. 2010. WISAARD Mapping.

Washington Department of Ecology (Ecology) and Washington State Department of Agriculture. 2004. Integrated Pest Management Plan for Freshwater Emergent Noxious and Quarantine Listed Weeds. Revised July 2004.

Washington Department of Fish and Wildlife (WDFW). 1997. Aquatic Plants and Fish. Publication number APF-11-97.

Washington Department of Fish and Wildlife (WDFW). 1998. 1998 Washington salmonid stock inventory appendix: bull trout and Dolly Varden. 437 p.

Washington Department of Fish and Wildlife (WDFW). 2001. Aquatic Nuisance Species Management Plan. Coordinated by Pamala Meacham of the Washington Department of Fish and Wildlife for The Washington Aquatic Nuisance Species Coordinating Committee. October 2001.

Washington Department of Fish and Wildlife. 2009. Priority Habitats and Species database search results prepared for The Watershed Company, September 2009.

Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. 1992 Washington State salmon and steelhead stock inventory. March 1993. Olympia, WA. 212 p.

Werner E.E. and D.J. Hall. 1988. Ontogenetic habitat shifts in bluegill: the foraging rate-predation risk tradeoff. Ecology 69: 1352-1366.

Williams, R.W., R.M. Laramie, and J.J. Ames. 1975. A Catalog of Washington Streams and Salmon Utilization, Vol. 1, Puget Sound Region. Washington Department of Fisheries.

Wood, C.C. and C.M. Hand. 1985. Food-searching behavior of the common merganser (*Mergus merganser*). I: functional responses to prey and predator density. Can. J. Zool. 63: 1260-1270.

WRIA 8 Steering Committee. 2002. Lake Washington/Cedar/Sammamish Watershed (WRIA) Near-Term Action Agenda For Salmon Habitat Conservation. August, 2002. http://dnr.metrokc.gov/wrias/8/near-term-action-agenda.htm

WRIA 8 Steering Committee. 2005. Lake Washington/Cedar Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan. July 2005.

9 LIST OF ACRONYMS AND ABBREVIATIONS

Corps.....U.S. Army Corps of Engineers

Ecology .....Washington Department of Ecology

GMA.....Growth Management Act

HPA.....Hydraulic Project Approval

LWD .....Large Woody Debris

NOAA Fisheries .....National Marine Fisheries Service

PAHs .....polycyclic aromatic hydrocarbons

PCBs .....polychlorinated biphenyls

PHS.....Priority Habitats and Species

SMA.....Shoreline Management Act

SMP .....Shoreline Master Program

USFWS .....U.S. Fish and Wildlife Service

USGS .....U.S. Geological Service

WDFW .....Washington Department of Fish and Wildlife

APPENDIX A

Inventory Map Folio

DRAFT

MINIMUM SHORELINE JURISDICTION

BEAUX ARTS VILLAGE SHORELINE MASTER PROGRAM

0 100 200
Feet

MAP LEGEND

- Shoreline Jurisdiction
- Town Boundary

THE WATERSHED COMPANY

Data: King County, City of Bellevue, TWC. February, 2010

All features depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

DRAFT

SHORELINE ASSESSMENT AREA

BEAUX ARTS VILLAGE SHORELINE MASTER PROGRAM

0 100 200
Feet

MAP LEGEND

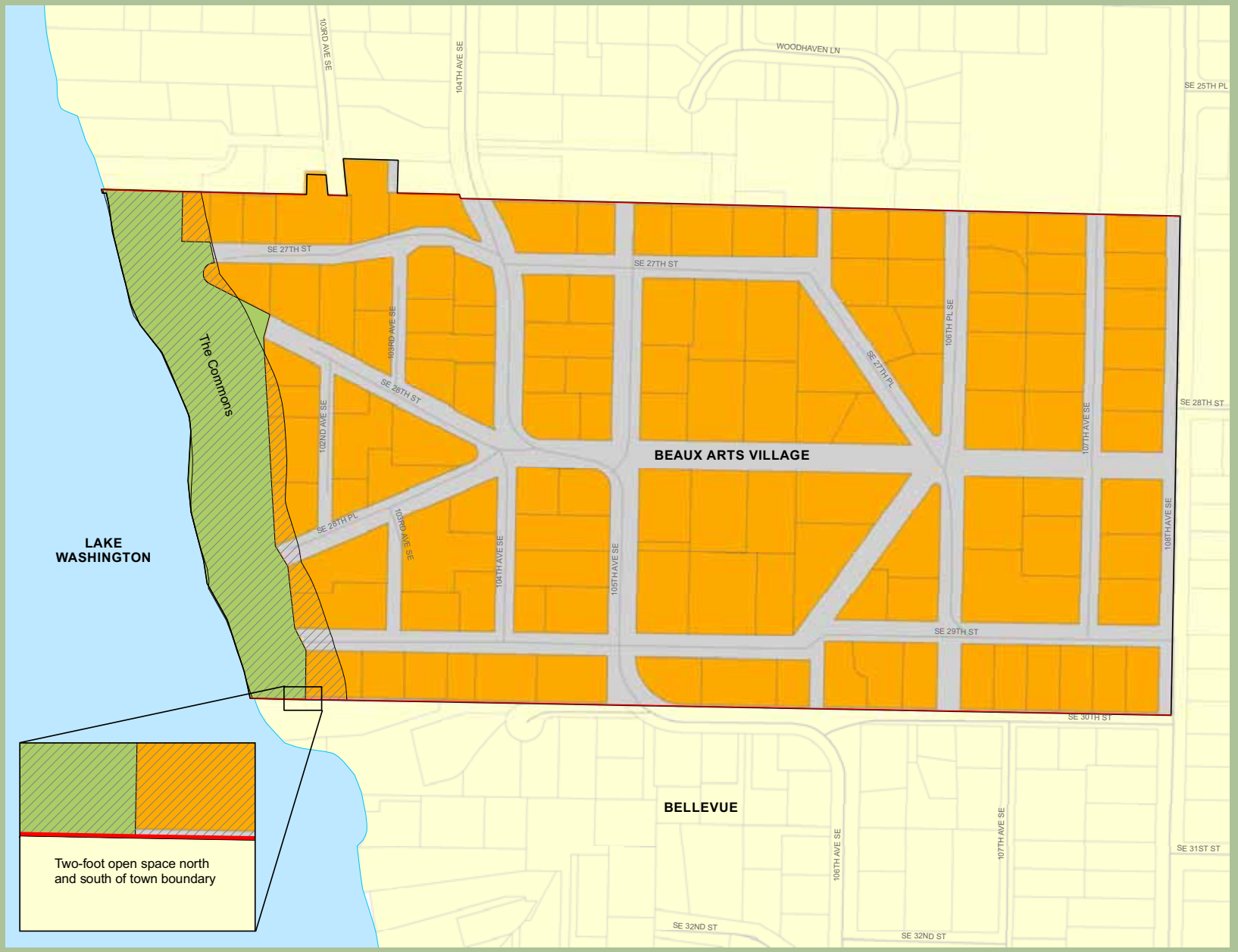
- Assessment Area 1 (WABA)
- Assessment Area 2
- Town Boundary

THE WATERSHED COMPANY

Data: King County, Town of Beaux Arts, TWC. June, 2010.

All features depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

DRAFT



COMPREHENSIVE LAND USE PLAN

BEAUX ARTS VILLAGE SHORELINE MASTER PROGRAM

0 100 200
Feet

MAP LEGEND

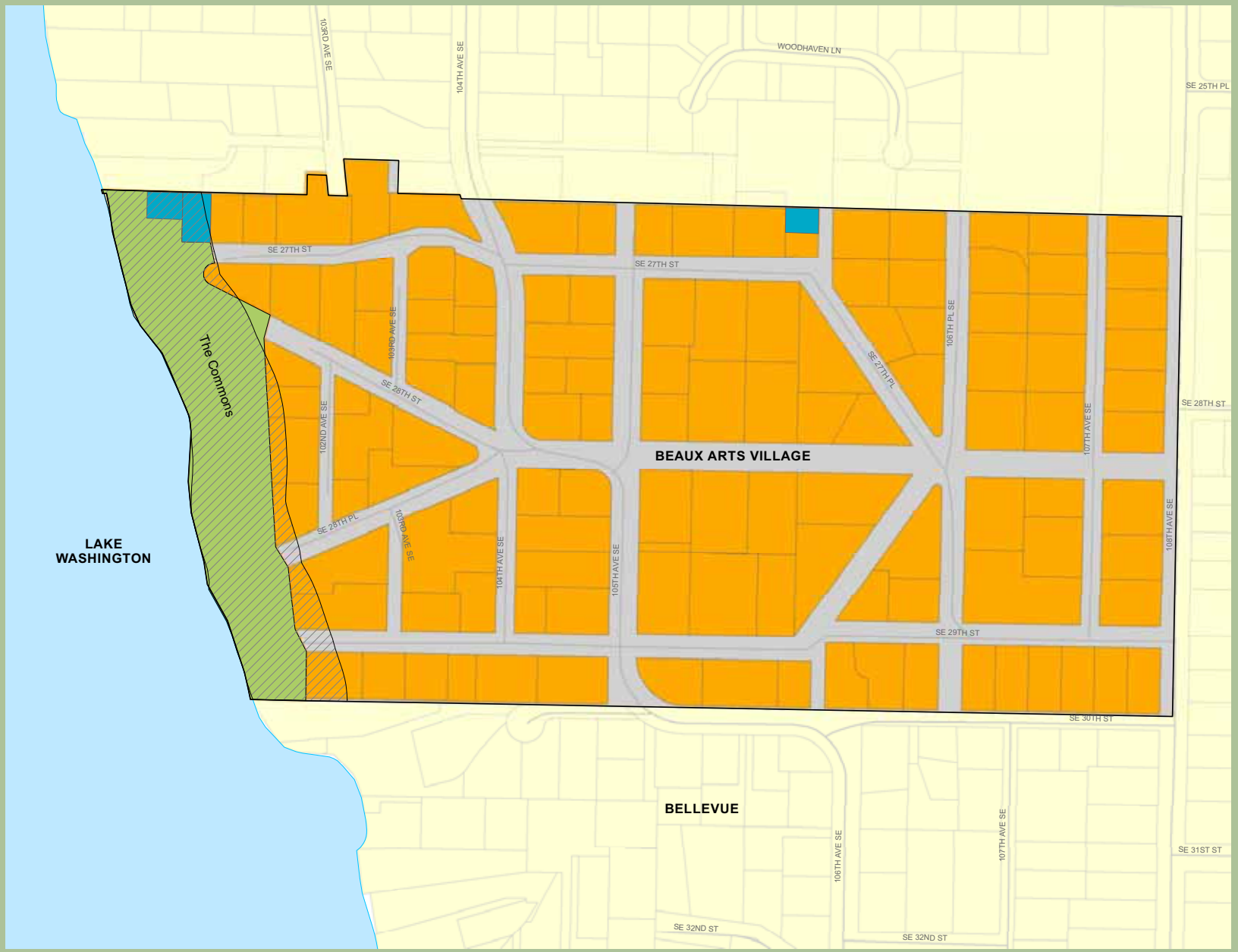
- 2' Buffer
- Open Space
- Single Family Residential
- Town Boundary
- Proposed Shoreline Jurisdiction

THE WATERSHED COMPANY

Data: King County, Town of Beaux Arts, TWC. February, 2010

All features depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

DRAFT



CURRENT LAND USE

BEAUX ARTS VILLAGE SHORELINE MASTER PROGRAM

0 100 200
Feet

MAP LEGEND

- Town Boundary
- Proposed Shoreline Jurisdiction
- Utilities
- Open Space (WABA)
- Single Family Residential

THE WATERSHED COMPANY

Data: King County, Town of Beaux Arts, TWC. June, 2010

All features depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

DRAFT

UTILITIES

BEAUX ARTS VILLAGE SHORELINE MASTER PROGRAM

0 100 200
Feet

MAP LEGEND

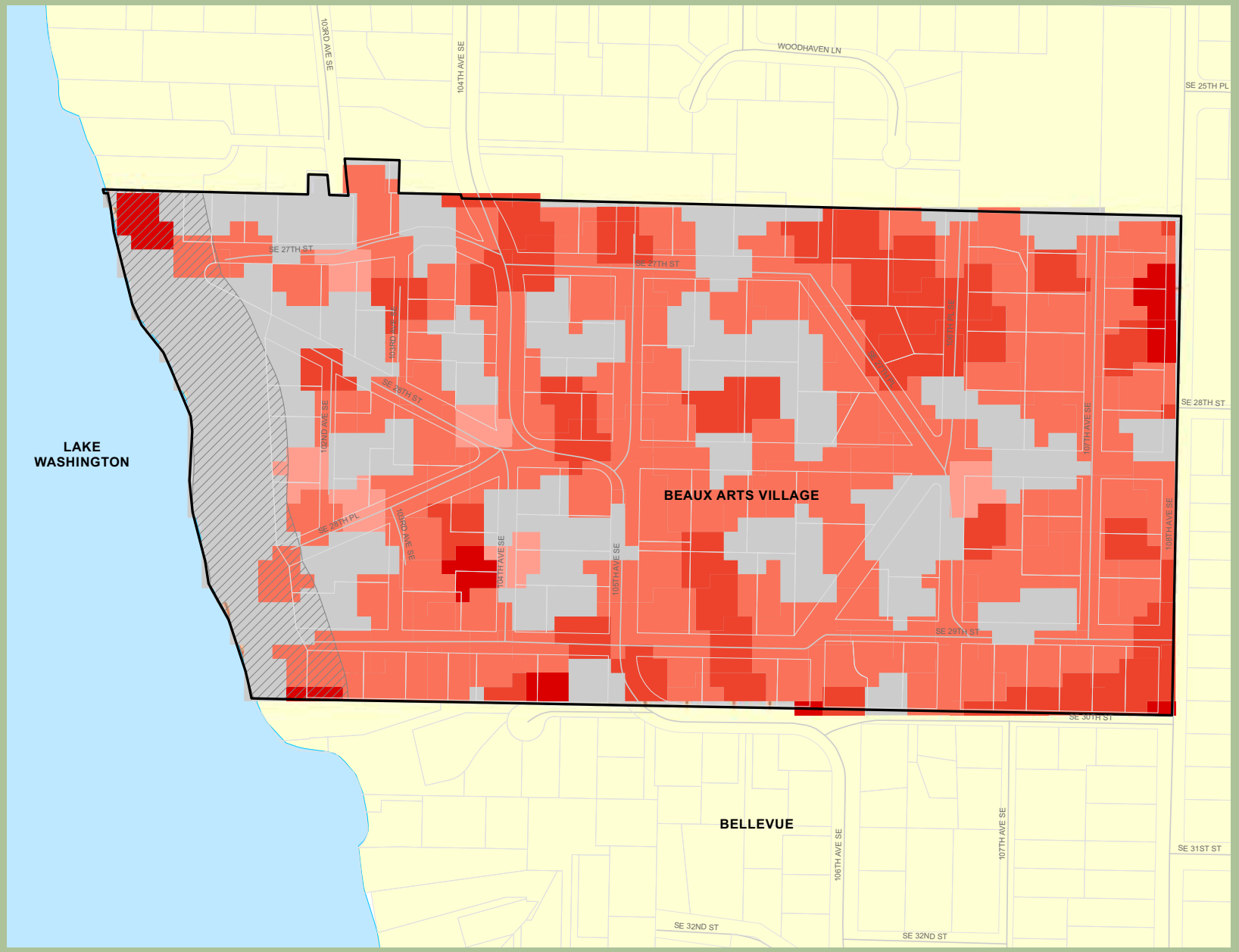
- Wells/Pump House/Water Tower
- City of Bellevue Sanitary Sewer
- Proposed Shoreline Jurisdiction
- Town Boundary

THE WATERSHED COMPANY

Data: King County, City of Bellevue, TWC. June, 2010

All features depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

DRAFT



IMPERVIOUS SURFACES

BEAUX ARTS VILLAGE SHORELINE MASTER PROGRAM

0 100 200
Feet

MAP LEGEND

Percent Impervious

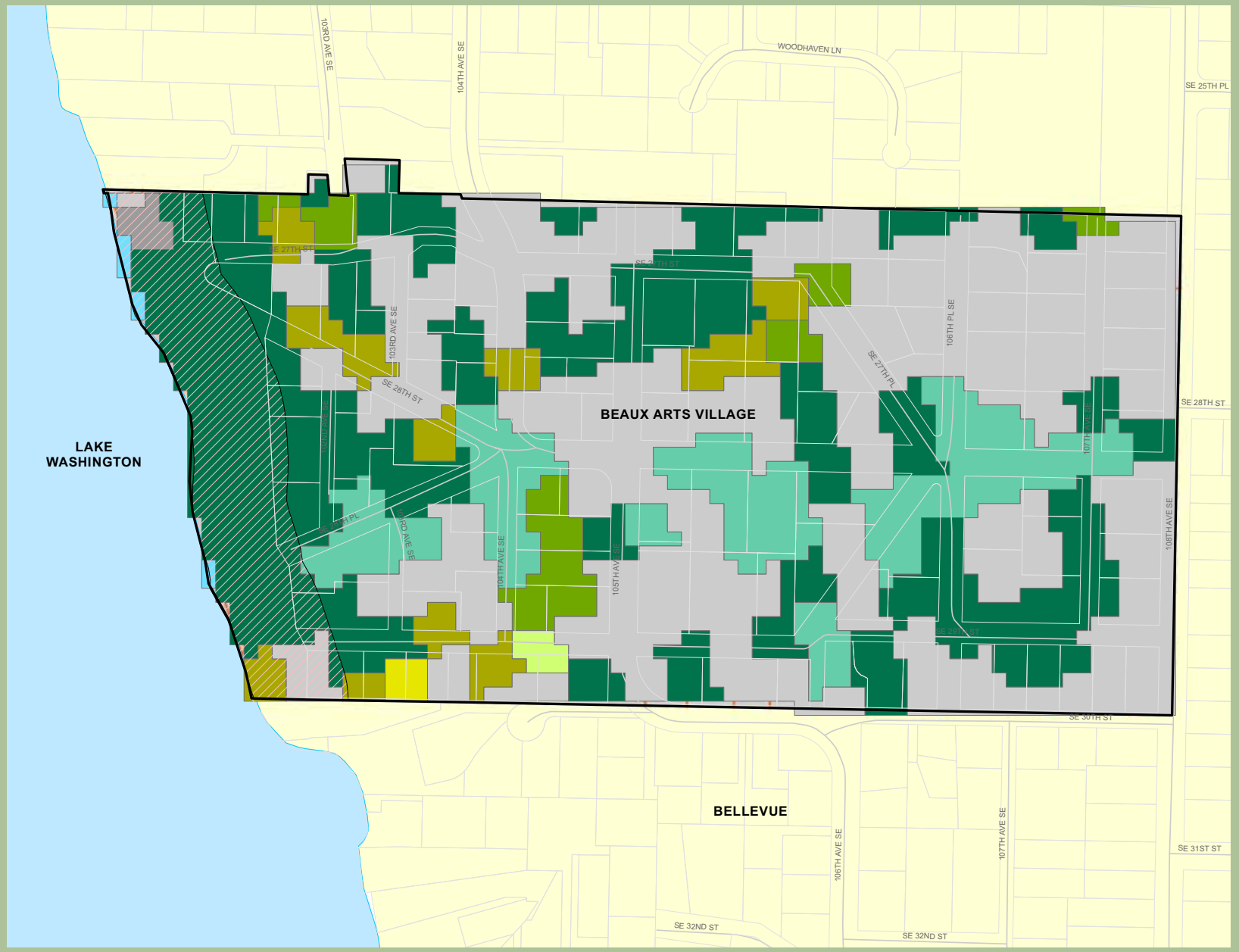
- 0
- 1 - 12
- 13 - 25
- 26 - 38
- 39 - 50
- Proposed Shoreline Jurisdiction
- Town Boundary

THE WATERSHED COMPANY

Data: King County, USGS, TWC. February, 2010

All features depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

DRAFT



NOAA CCAP LAND COVER ANALYSIS: VEGETATION

BEAUX ARTS VILLAGE SHORELINE MASTER PROGRAM

0 100 200
Feet

MAP LEGEND

- Medium Intensity Developed
- Low Intensity Developed
- Developed Open Space
- Evergreen Forest
- Deciduous Forest
- Mixed Forest
- Palustrine Forested Wetland
- Palustrine Scrub/Shrub Wetland
- Water
- Proposed Shoreline Jurisdiction
- Town Boundary

THE WATERSHED COMPANY

Data: King County, NOAA CCAP,TWC. February, 2010

All features depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

DRAFT

PUBLIC ACCESS AREAS

BEAUX ARTS VILLAGE SHORELINE MASTER PROGRAM

0 100 200
Feet

MAP LEGEND

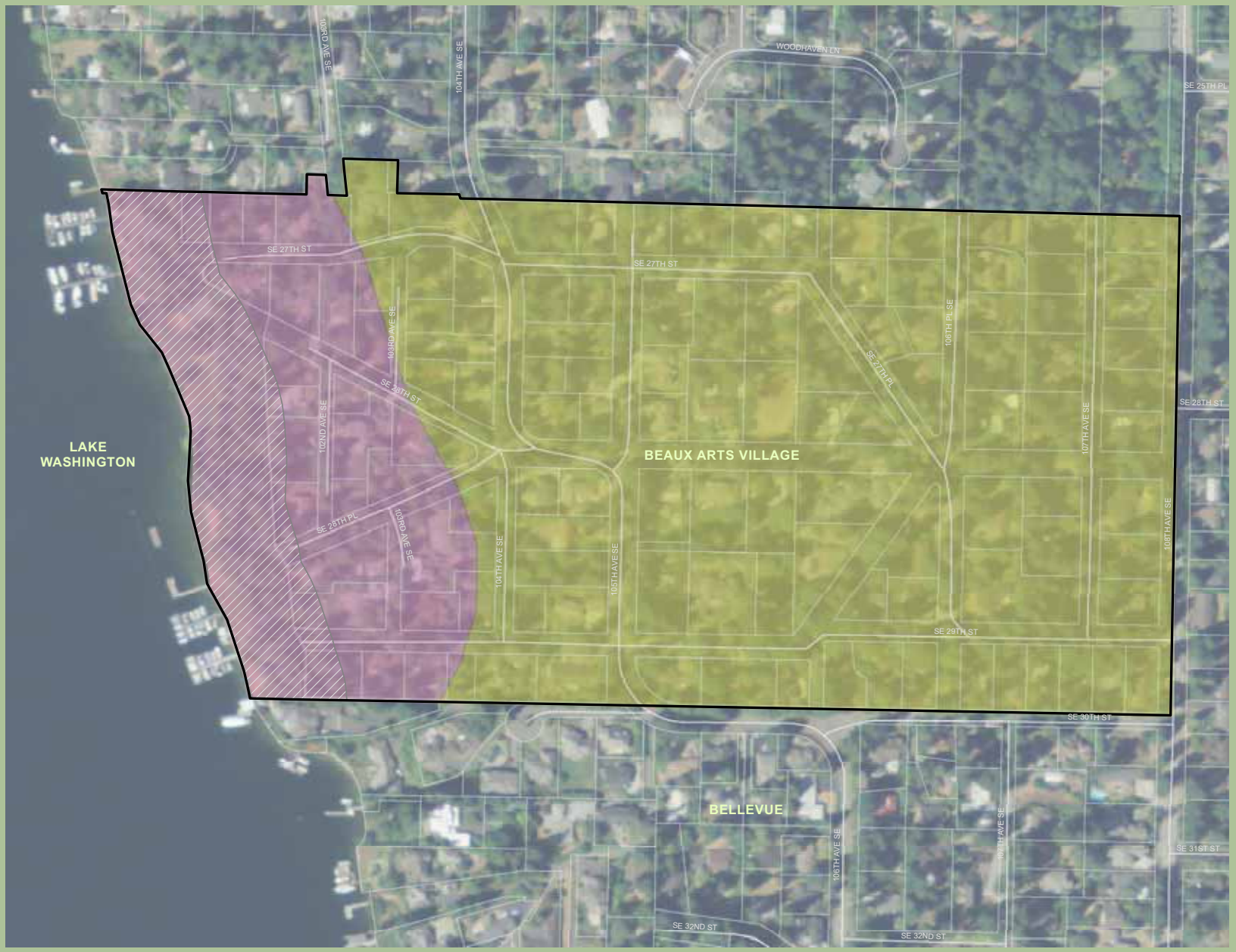
- Private Park
- Proposed Shoreline Jurisdiction
- Town Boundary

THE WATERSHED COMPANY

Data: King County, City of Bellevue, TWC. February, 2010

All features depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

DRAFT



NRCS SSURGO SOILS

BEAUX ARTS VILLAGE SHORELINE MASTER PROGRAM

0 100 200
Feet

MAP LEGEND

Soils

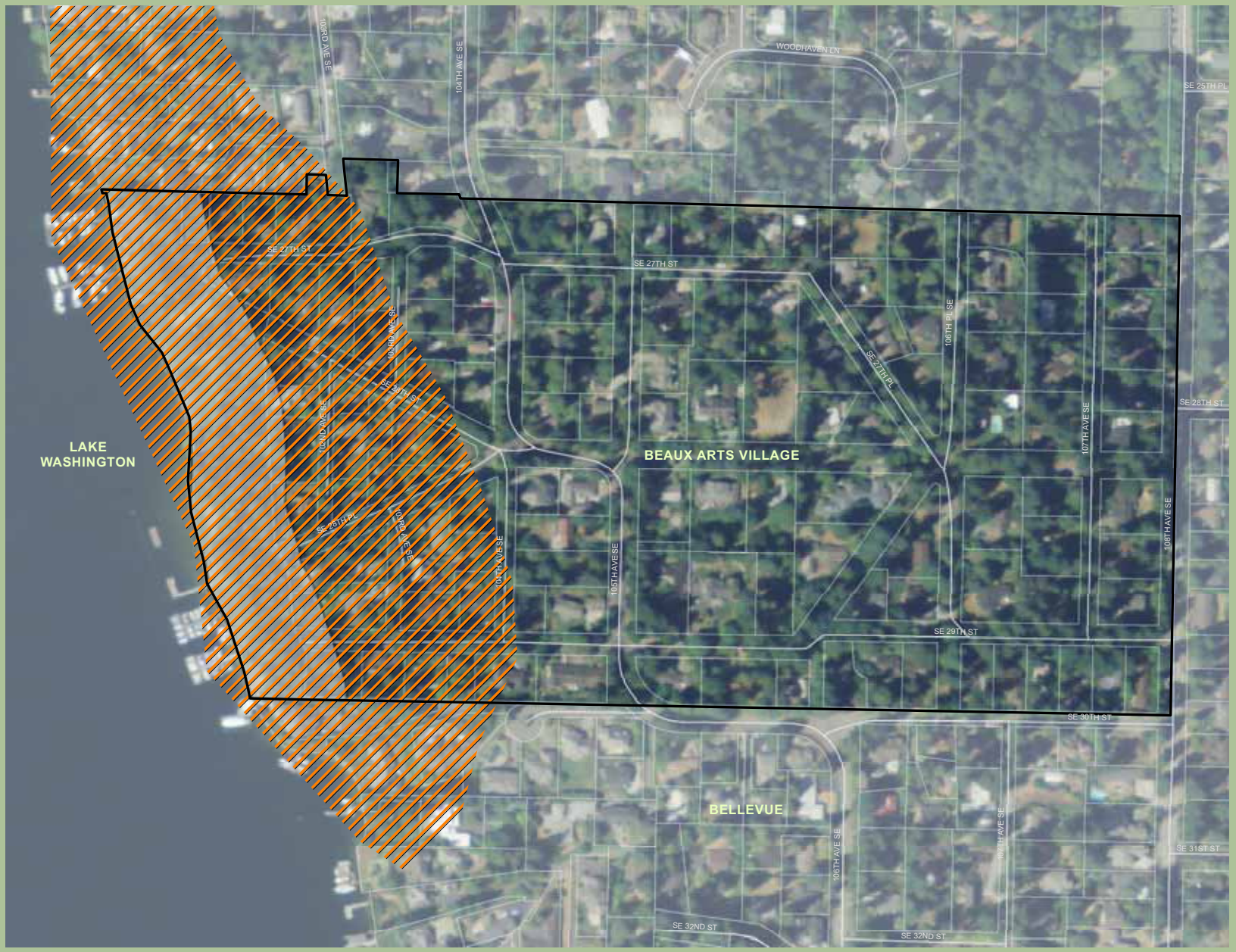
- Everett-Alderwood gravelly sandy loams
- Kitsap silt loam
- Proposed Shoreline Jurisdiction
- Town Boundary

THE WATERSHED COMPANY

Data: King County, NRCS SSURGO, TWC. February, 2010

All features depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

DRAFT



EROSION HAZARD AREAS

BEAUX ARTS VILLAGE SHORELINE MASTER PROGRAM

0 100 200
Feet

MAP LEGEND

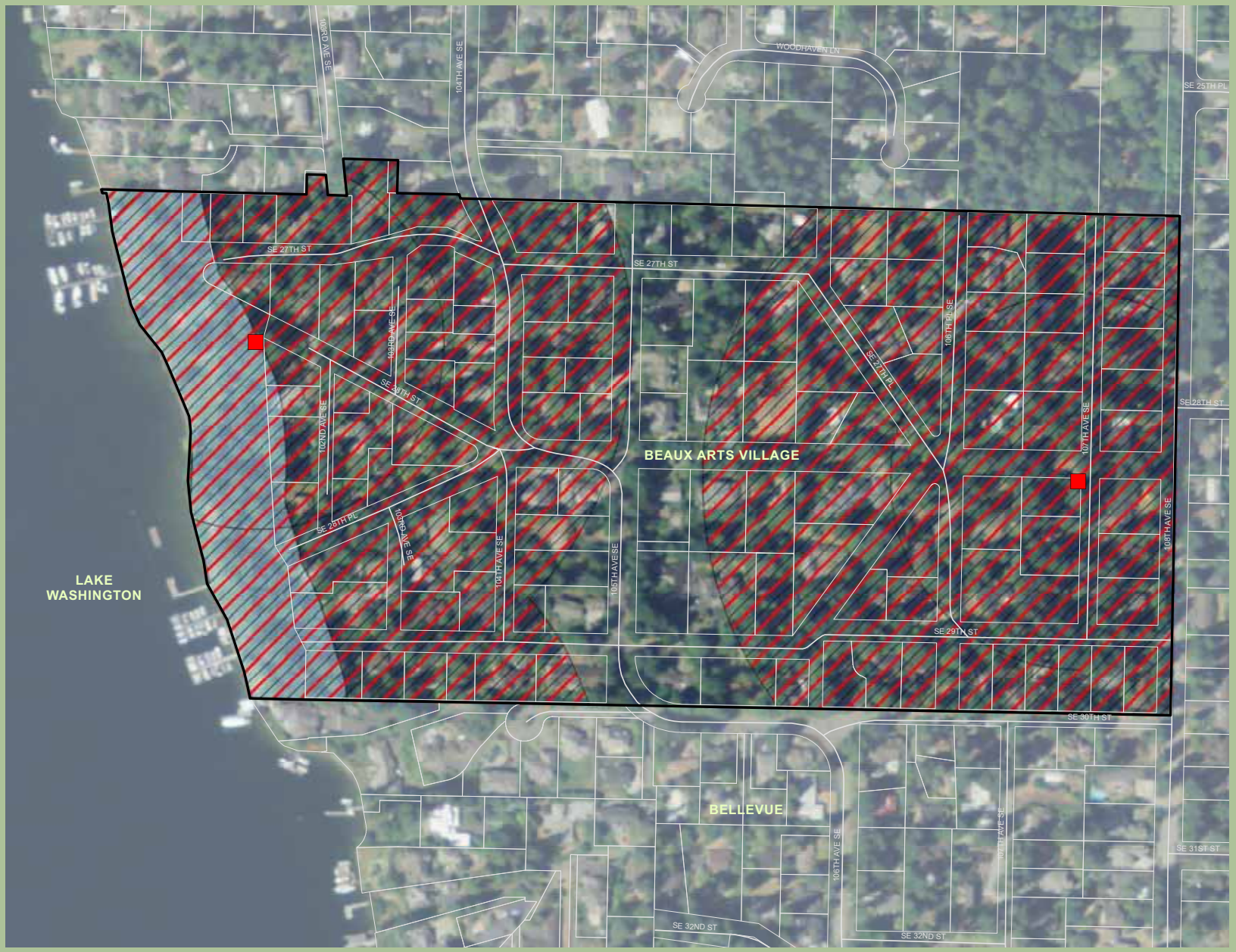
- Erosion Hazard Areas
- Proposed Shoreline Jurisdiction
- Town Boundary

THE WATERSHED COMPANY

Data: King County, TWC. February, 2010

All features depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

DRAFT



WDFW PRIORITY HABITATS & SPECIES

BEAUX ARTS VILLAGE SHORELINE MASTER PROGRAM

0 100 200
Feet

MAP LEGEND

- Bald Eagle Nest
- Bald Eagle Buffer*
- Proposed Shoreline Jurisdiction
- Town Boundary

** Buffers of bald eagle nests, communal roosts, and shoreline that fall within a half-mile of nests.*

A wetland mapped in error by WDFW is not shown.

THE WATERSHED COMPANY

Data: King County, WDFW, TWC. June, 2010

All features depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

DRAFT

SHORELINE MODIFICATIONS

BEAUX ARTS VILLAGE SHORELINE MASTER PROGRAM

0 100 200
Feet

MAP LEGEND

- Overwater Structures*
- Rockery
- Town Boundary
- Proposed Shoreline Jurisdiction

** Data has been revised to reflect current conditions.*

THE WATERSHED COMPANY

Data: King County, DNR, City of Bellevue. TWC. July, 2010

All features depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.